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Cutting Coal Cost

STOPPING LEAKING BYPASS, INSTALLING LARGER HEATER, AND REBUILDING BRIDGEWALL ARE AMONG CHANGES THAT RESULT IN HALVING COAL BILL

NOT MANY YEARS ago power plant machinery was installed in Wieboldt's department store in Chicago, and after it had been in operation a few years it became a problem of the engineering force to keep the plant from being turned over to the central station. About this time the plant was put in charge of the present chief engineer, G. E. Ocain, with full authority, thus eliminating interference by those not informed on engineering matters, and the marked improvement which has been made in operating expense is evidence of the careful handling and scientific management of the plant.

In the boiler room are 4 Kroeschell return tubular boilers each having a capacity of 150 hp. and worked at a pressure of 125 lb. The boilers are equipped with Williams safety water columns and feed water regulators. Feed water enters through the blowoff connection. In the blowoff line is an angle blowoff valve followed by a cock, the discharge being to a header and basin.

Two boilers are placed in one setting, making 2 settings in the plant with passageway between. The boilers are served by Green chain grates which are operated from an overhead shaft driven by a motor under hand control of the fireman.

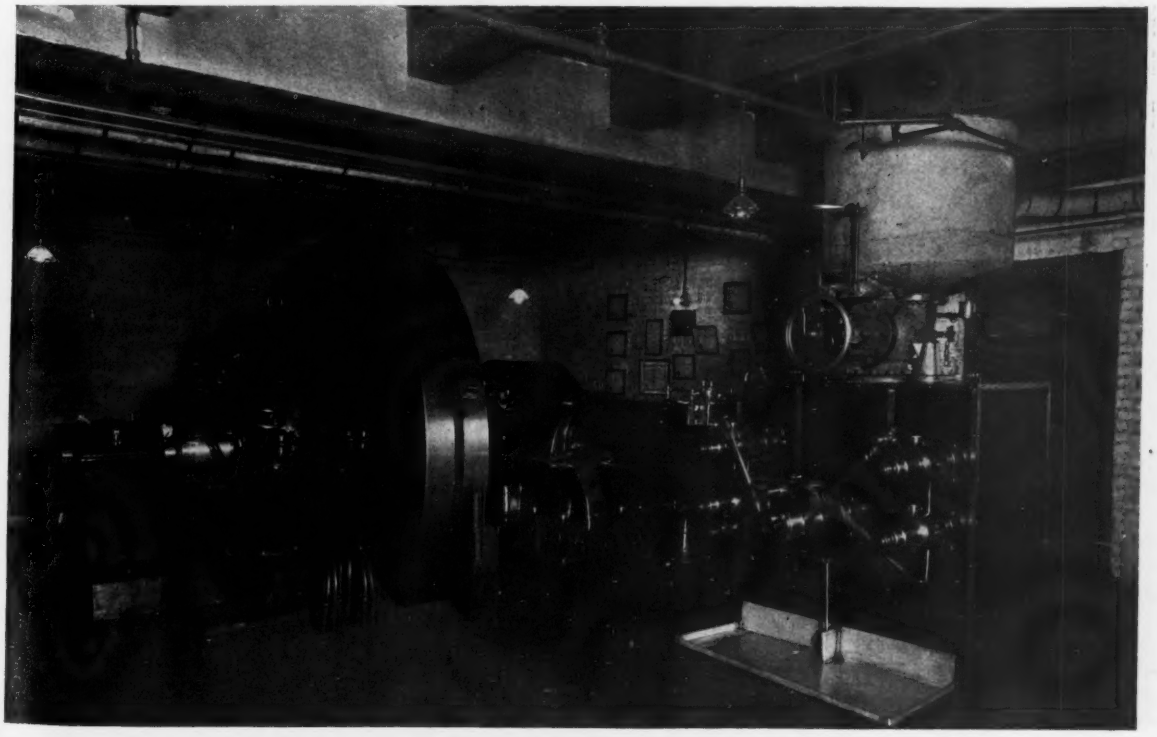


FIG. 1. MAIN GENERATING UNIT IN WIEBOLDT'S PLANT

One of the distinct features of the plant is a draft gage system made by the engineer. A manifold taken from an automobile serves as a convenient connection between the gage and the pipe lines, each provided with a cock, leading to the breeching and to each combustion chamber. The gage is filled with oil, which does not evaporate rapidly, and calibrated against a water gage. A metal protection covers the end of the gage to prevent dust from settling in it. The draft gage, as well as a stack damper lever and control handle for the stoker motor are located on a post in the center of the boiler room, making it convenient to read draft, regulate damper and speed of the grate while in the most convenient place to watch the boilers. The accompanying chart shows how even the steam pressure is maintained by this system, comparing favorably with automatic regulation.

FIG. 2. CONTROL POST IN BOILER ROOM SHOWING DRAFT GAGE, STOKER MOTOR CONTROL HANDLE AND DAMPER LEVER

Coal is delivered to the bunker in front of the boilers from the alley and shoveled by hand to the hoppers of the grates. The ash is scraped to a pit in front of each boiler, then shoveled into barrows and wheeled to a bin from which a bucket elevator takes it to wagons in the alley.

Feed water is taken from the city mains to a Cochrane heater of 300 hp. capacity which, during the heating season, is run on about 1½ lb. pressure and heats the water to 213 deg. F. From the heater the water is delivered by Deane pumps to the boilers; one of these is a simplex outside centerpacked plunger pump, the other a duplex, both under the control of Foster pump governors.

Water for house use is pumped to a tank on the roof by a Platt Iron Works triplex single acting power pump driven by a silent chain from a motor under automatic control from a float in the tank.

Generating equipment consists of 3 Ball & Wood engines direct connected to Sprague Electric Co. generators. No. 1 is an automatic slide valve engine run at 290 r.p.m., driving a 50-kw. generator which delivers direct current at 112 volts. No. 2 is of the 4-valve positive gear type with flywheel governor and 2 eccentrics run at 150 r.p.m. and connected to a 150-kw. generator. No. 3 is the same as No. 2 except that it is larger, being designed to drive a 200-kw. generator.

A 7-panel switchboard is located in the engine room; 3 panels have instruments and switches for the generators and 3 for distributing circuits, while one panel has the pressure gages of the plant mounted upon it.

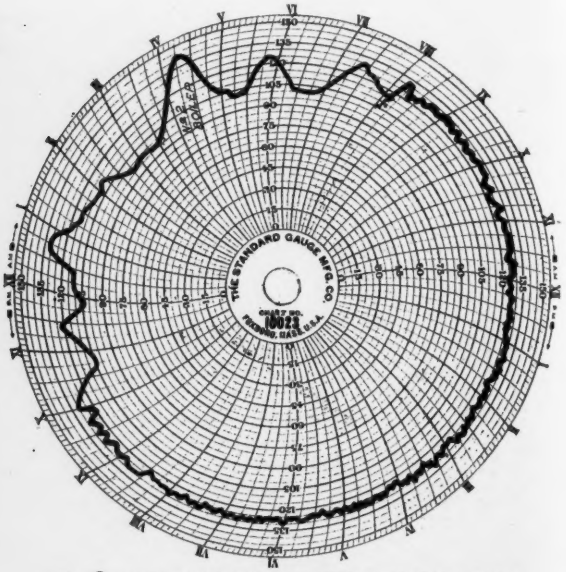


FIG. 3. CHART FROM RECORDING PRESSURE GAGE

Besides the lighting load of the store the plant furnishes current for 30 motors and 4 electric elevators; there are also 3 steam elevators in the building.

Refrigeration is needed for drinking water, fish, meat, cheese and butter, and this is furnished by a 15-ton Wolf-Linde machine. Indirect cooling is employed except for a box on the shipping room floor, which is cooled by direct expansion.

Improvements and Results

Throughout the entire plant careful observation will reveal devices and original schemes to save labor, oil, steam, etc., as well as improve operating efficiency. The first important improvement made by the engineer had to do with bypass valves around 3 traps that drain the separators in the lines to the engines. These were gate valves and were found to be leaking badly. It was impossible to prevent this leak with the old valves, so new globe valves were put in and with other less important improvements during this first month the coal bill was reduced from that the same month of the previous year from $1040 to $725. This was for November, 1913.

The next important change affected the house water heater. In order to heat the required amount of water

it was necessary to carry a back pressure on the engines of 4 lb. on a 300-hp. load, while during the summer time steam was exhausting to atmosphere through the back pressure valve. It was thus apparent that this heater was too small, so a larger heater was installed at an expense of $268, and the back pressure reduced to atmospheric. This change resulted in a saving in fuel of $62 a month.

Another important change was made in March, 1915, which resulted in a saving of $72 a month in the coal bill. The chain grates employed had been equipped with waterbacks, these, however, had burned and rusted out, and as the water used to keep them cool was run to the sewer, making an unnecessary expense, they had been removed. As a result a large opening was left between the rear end of the grate and the bridge wall, which cut down the available draft, gave an excess air supply, thus reducing furnace temperature and the capacity of the boilers. To remedy the difficulty the engineer designed a new bridgewall, extending it over the end of the grate past the breaking point of the links, and did away entirely with the waterback.

Changes were also made in the operation of the grates. Under the old conditions there was no means for controlling the speed of the grate, which ran at about 15 ft. an hour. This necessitated a thin fire, for if the feed gate was raised, at this speed of the grate, the fuel would not ignite under the arch, and side firing had to be resorted to. With the thin fire it was practically impossible to prevent holes in the fuel bed.

Present practice is to maintain a fuel bed 6 to 7 in. thick and regulate the draft and speed of the grates to suit load condition, the latter averaging about 5 ft. an hour. This gives time for combustion to be entirely completed and clinker sufficiently cooled to prevent it from adhering to the bridge wall.

By the use of the draft gage already described the firemen are able to regulate draft to suit working conditions and detect faults in the combustion system. Draft in the breeching is usually carried at 0.2 to 0.3 in., while in the combustion chambers, if grates are sufficiently covered, it shows 50 per cent drop, thus giving a draft of from 0.1 to 0.15 in., a greater drop in draft indicates holes in the fire. Draft is controlled by the stack damper, but each boiler has its own damper, these being kept wide open except when the soot is being blown from the tubes or the boilers are out of service.

Hand operated steam soot blowers are used twice a day, and the boilers are blown down once a day when the load is light. Two boilers are sufficient for carrying

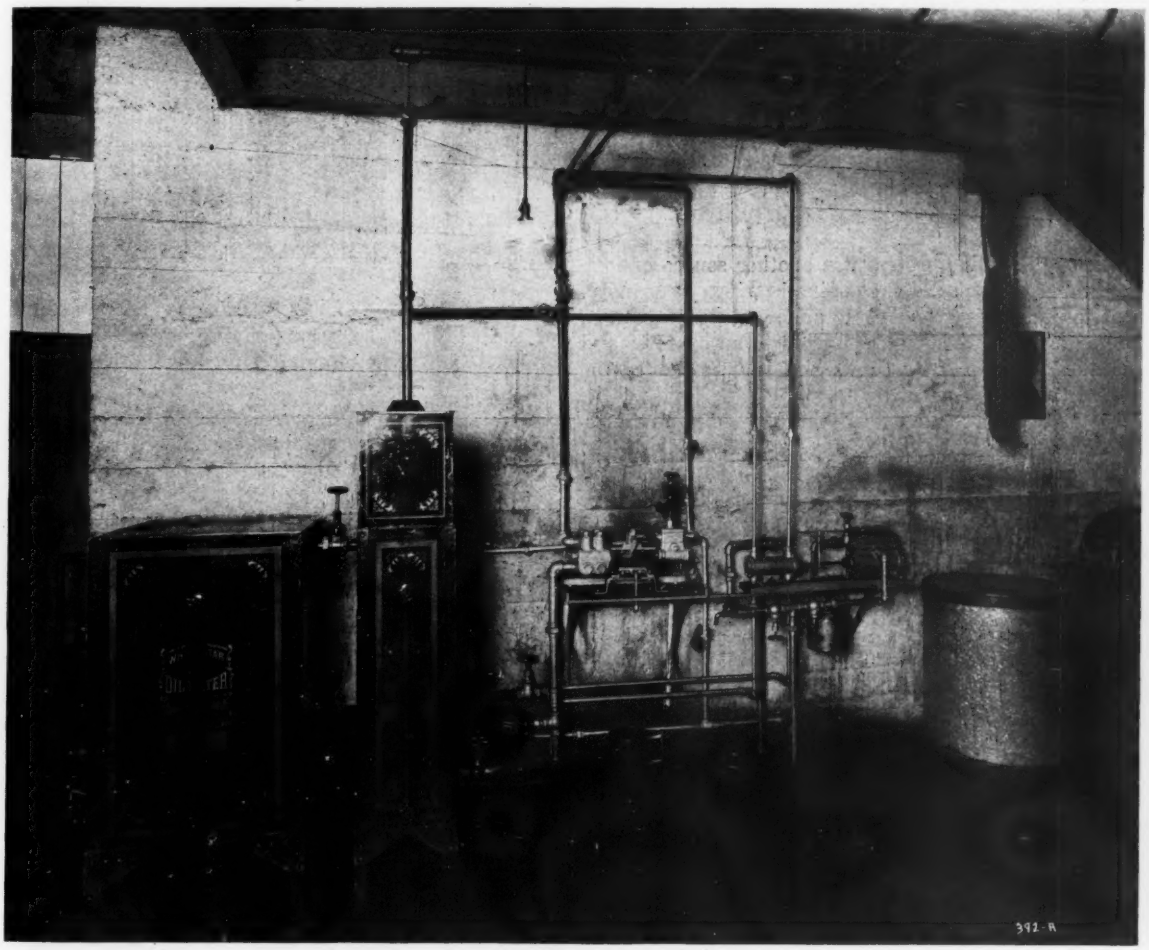


FIG. 4. OIL HANDLING EQUIPMENT SHOWING WATER-DRIVEN PUMP TO THE RIGHT

the load, so that a 2-weeks' run is made with the boilers in one setting alternated by those in the other. During the idle period the boilers are given a thorough inspection and cleaning inside and out.

It had been the practice to treat the feed water by introducing a compound into the heater once a day, as the means available would not allow a continuous feed against the back pressure carried. The result was that shortly after the compound was introduced the boiler would prime, causing an occasional dose of water in the engines and pumps; and the heater was continually becoming clogged with scale.

To overcome this, a different compound was used and introduced to the heater continuously by means of a small pump made by the engineer and attached to the boiler feed pump. The compound mixes with the water in the upper part of the heater, thus giving a thorough mixture before the water becomes hot enough to precipitate impurities. The results secured are a clean heater, which may be worked far above rating, increased feed water temperature, cleaner boilers and no priming. The compound pump is made from pipe fittings and check valves.

The engine oiling system was another source of loss. An elevated oil tank fed the engine bearings by gravity, the drippings going to a well under the engine room floor. From the well it was pumped to an oil filter and from the filter reservoir it was again pumped to the elevated tank.

In the former arrangement the oil pump was operated by steam, it had but one suction and one discharge, making it necessary to watch the oil levels in the well and filter and to operate valves changing over from one service to the other. An overflow was provided for the drip well and sometimes this well overflowed, causing in a short time an enormous waste of oil.

All this inconvenience of operating valves to change suction and discharge from the pump, also the waste of oil to sewer and use of steam, has been overcome by installing a pump designed and made by the engineer, operated on city water pressure, the water used being delivered to the surge tank of the house water system. The oil pumping end is of the double acting type, but has the connections to each end of the pump separate, thus making 2 suction and 2 discharge pipes, one suction and discharge handling the oil from the well to the filter, the other delivering the oil from the filter to the elevated tank. There is no overflow of the well nor the filter, as each end of the pump handles the same amount of oil and the pump is regulated to keep the well and filter empty, all oil is clean and in reserve tank, requiring about ½ amount of oil in system, and effecting a saving of 28 per cent in the yearly oil bill.

MONTHLY COAL COSTS FOR 4 YR.

	1912	Present Management. - 1913	1914	1915
Nov.	1040	725	710	663
Dec.	1117	872	905	817
Jan.	1080	1066	802	764
Feb.	982	867	715	588
Mar.	1084	972	749	716
Apr.	1150	992	709	575
May	1049	876	657	637
June	1024	821	699	703
July	1054	818	737	660
Aug.	1109	742	708	660
Sept.	986	708	637	635
Oct.	1096	808	755	673

Another source of loss was due to the valve settings of the engines; the accompanying cards show how the engines had been running and what effects the final adjustments made upon the cards.

In the accompanying record of coal bills it is interesting to note the gradual decrease as well as the sudden drops due to important changes noted above. The present engineer took charge in November, 1913. During all this time the load on the plant has increased, but not sufficiently to destroy the value of the comparison of coal bills.

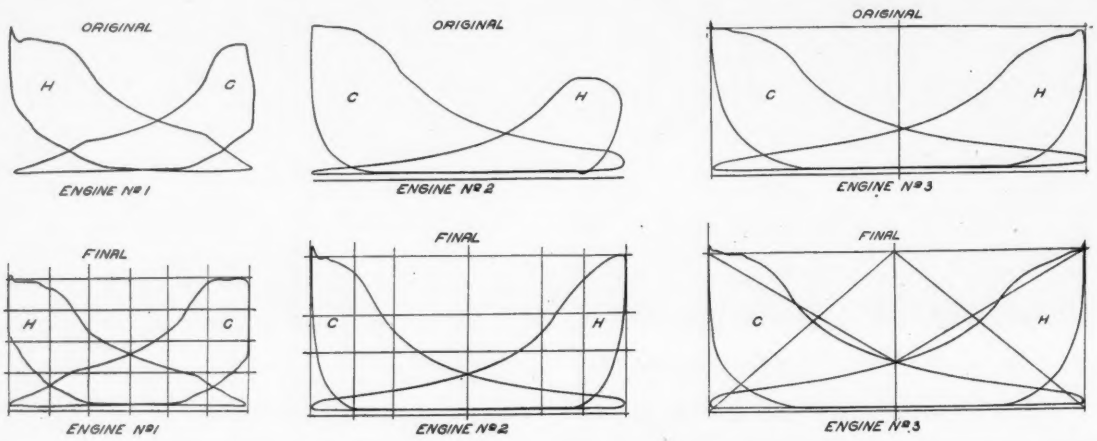


FIG. 5. ORIGINAL AND FINAL INDICATOR CARDS FROM THE GENERATOR UNITS

In Bradford, Eng., the city electric department reports, for the year ending Oct., 1915; receipts of $718,218 and net profit $92,249, but data is not available as to allowance for overhead expense. $33,628 was expended on capital works and $555 applied on depreciation of meters in stock, $24,333 being appropriated to lowering of city taxes.

Fire Fighting and Fire Prevention---II*

DESCRIPTIONS OF PUMPS, TANKS AND RISERS USED IN FIRE FIGHTING SYSTEM OF A MODERN LOFT BUILDING. BY FRANK WILLIAMS

COMPLETE interior systems of fire fighting are also provided in this building for the protection of life and property, and these consist of standpipes and hose, automatic sprinklers, and auxiliary apparatus. For these systems there are provided 2 independent sources of water supply; namely, a 6-in. driven well within the building, and City Croton water.

Two motor-driven pumps are provided to handle these supplies, one being a 24-in. stroke deep well pump of the direct double-acting pattern, which may also be operated on the city water, delivering 100 gal. per min. at 35 revolutions and operated by a 10-hp. variable speed motor. This deep well pump, including the motor, piping connections, valves and completely installed, cost $800. The other pump is a 6 by 8-in. triplex, connected to handle the city water at a rate of 130 g.p.m. when run by a 10-hp. electric motor at 43 r.p.m. This triplex pump complete with motor and installed also cost $800. In addition to this pumping arrangement, there is also provided a small triplex house pump.

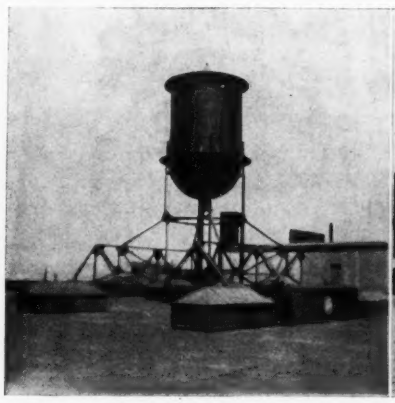


FIG. 1. GRAVITY SPRINKLER TANK

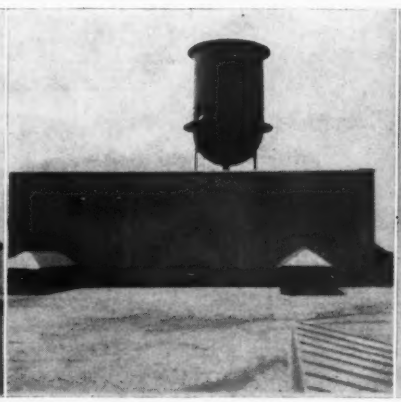


FIG. 2. GRAVITY TANK AND PRESSURE HOUSE

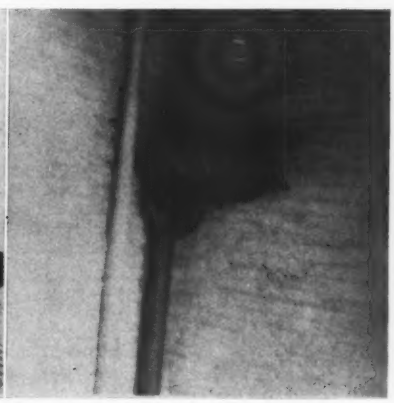


FIG. 3. FIRE HOSE STANDPIPE AND RACK

An open steel tank, 6 by 7 by 14 ft. in size, mounted on steel beams about 3 ft. above the roof, at a total cost of $350 in place, is designated as the house tank. It has a storage capacity of 4000 gal. of water and though primarily intended as a reservoir for the fire standpipe and hose system, it normally supplies the sanitary requirements of the building.

The triplex fire pump is supplied with a 3-in. suction and the well pump is, of course, connected to the 6-in. casing, both being properly cross-connected and valved, discharging into a 4-in. pipe which is extended to the roof for filling the house tank.

From the tank there is taken a 4-in. line, having a gate and horizontal check valve and extended to the basement. This line is used as the standpipe for the south stairway, having attached to it at every floor, through a 2½-in. angle valve connection, 100 ft. of fire hose with nozzle. A 4-in. main is extended in the basement, cross connecting the heel of this riser with the other 2 stairway standpipes, which are similarly equipped with valves and fire hose. Three branch pipes, 4-in. size, tie into this main with check valves, each being dripped and extended through the building walls to one of the streets, there terminating with siamese twin connections, for the use of the fire department, and marked with metal signs designating their functions.

Hose used is of linen, 2½-in. approved underwriters pattern, coupled in 50-ft. sections, folded and laid flat on a rack attached to the wall. To each floor connection of 100 ft. of hose is attached an iron nozzle 1¼ by 2½ by 12 in. long, all of which amounts to $30 per floor connected, exclusive of the standpipe. The standpipes are standard weights, galvanized iron pipe, and completely installed with the main valves and connections, amounts to $850.

The form of rack as used in this installation is not to be recommended, because the hose becomes kinked at each fold and in time rots, so should the water pressure be applied in time of necessity, the hose may prove to be defective and burst at the creases, as has been found the case in more than one instance. In order to avoid these many folds, a reel may be used to advantage, on which the hose may then be coiled.

For any fire-fighting system to be effective, all parts should be properly proportioned for the service, and a not uncommon practice in designing standpipes is to allow a cross-sectional area of a 2-in. pipe for each hose outlet of 2½-in. size and a nozzle opening of 1¼ in. This method provides for both a sufficient volume and pressure for an effective fire stream when all hose on that line are being used. Thus, by referring to a pipe equation table, and using the above, on a basis of 11 connections for a standpipe, then it is seen that at least a 5-in. pipe is required.

This condition corresponds to the building under consideration; but only a 4-in. line is provided, prob-

*Part I of this series appeared in the Dec. 1, 1915, issue.

ably having been proportioned on a basis that not more than ½ the connections on a riser, will be called into service at one time. For convenience in determining the size of standpipe required when all the hose are in use on any line of an installation having 2½-in. hose, the following table is presented:

No. of Connections	1	2	3	4	5	7	8	12	13	19	20	30
Size of Standpipe, Inches	2	2½	3	3½	4	4	5	5	6	6	7	7

In order to be free of reliance on the standpipe and fire hose equipment and also to effect a considerable reduction in insurance costs, an automatic wet pipe sprinkler system was installed.

There is no question that sprinklers afford the best known means of protection in a manufacturing building. The sprinkler head proper is a simple valve, sealed shut by means of a fusible metal, and when reached by the temperature of fire, the fuse melts, thus opening the valve and allowing the water to discharge. It should be remembered that only such sprinklers as are reached by the heat of fire are caused to operate. Therefore, the distribution or sprinkling which follows is directly above the fire which caused the operation; and thus the merchandise or other property affected soon becomes saturated beyond the point of ignition.

The pumps heretofore mentioned are, of course, available for sprinkler service; an extensive amount of water, however, is always available, being stored in the tanks of the double supply system and aggregating a capacity of 60,000 gal.

One steel standard sprinkler gravity tank of 40,000 gal. capacity and 17 ft. in diameter by 26 ft. 6 in. high exposed and mounted on a built-up steel tower, 21 ft. above the roof, forms one reservoir for the required sprinkler water supply. The steel tower rests on the building columns, spanning 38 by 42 ft. on centers.

The tank proper is built of steel plate in 4 courses, the bottom being of 5/16-in. material and the upper courses ¼ in. thick. All joints are lap joints with the vertical seams double riveted and the girth seams single riveted. A conical steel roof, well braced, covers the top of the tank and a gallery or platform is also provided at a lower level around the tank. In this cover is set a substantial trap door of steel, so as to allow easy access to the inside of the tank; it is equipped with hinges, catch and ring. Beneath the steel tank roof is set a flat, wooden cover which acts as a support for the tank filling pipe and alarm connections; at the same time, the air space thus provided, tends to reduce in summer the heating of the water in the tank.

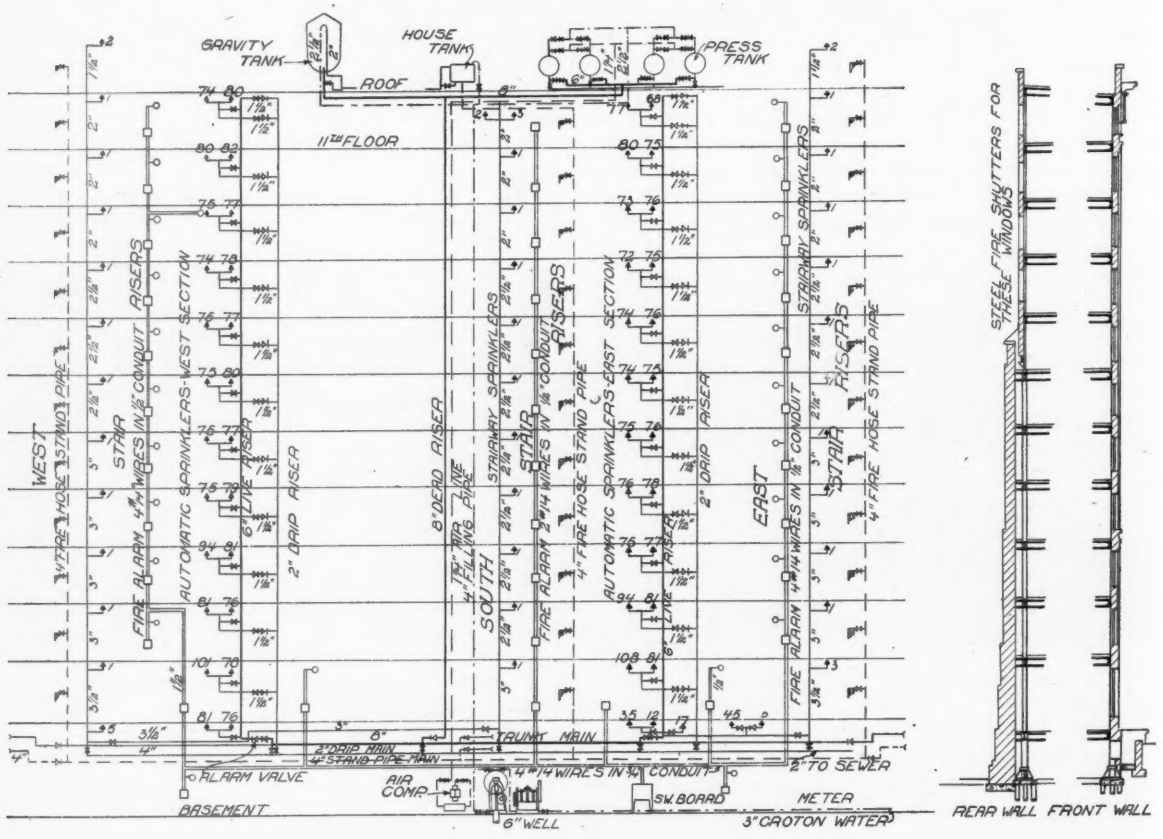


FIG. 6. ELEVATION OF FIRE PROTECTION SYSTEM

For reaching the top of the tank, there is provided a permanent, substantial wrought-iron ladder with rings of bar iron shouldered and riveted at the ends. This ladder extends from the roof to 3 ft. above the tank, terminating in a goose-neck and is supported from the ironwork and braced to the tank. Also a wooden ladder, extending from the top to bottom is secured inside of the tank.

The tank is provided with reinforced outlets for the piping connections and a water level indicator.

The remaining 20,000 gal. of water for the sprinkler system are stored in 4 steel pressure tanks, enclosed by a tank house on the roof. This pent house is built of light steel sections and terra cotta blocks, with the outside finished in cement stucco and the roof covered with 4-ply tar and gravel roofing; a fireproof door and metal sash with wire glass are also provided to allow for light and access to the tanks.

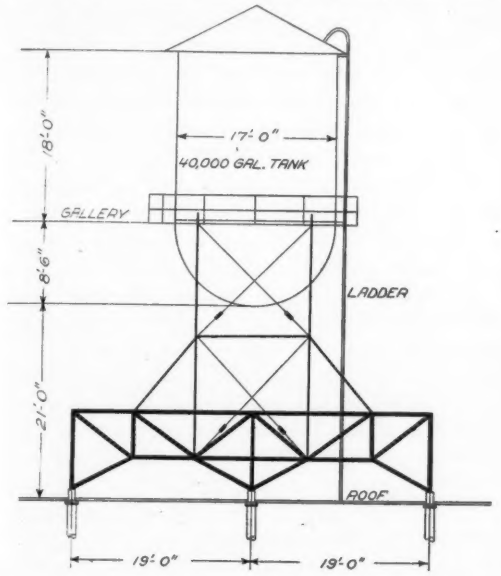


FIG. 4. STEEL GRAVITY TANK FOR AUTOMATIC SPRINKLER SYSTEM

The 4 pressure tanks are each designed for 7500 gal. but are kept only ⅔ full of water, the remaining space containing air at a pressure of 75 lb. per sq. in. The tanks are each 7 ft. in diameter and 26 ft. on the shells, built of steel plate in 4 courses with dished heads. Each tank rests on 4 wrought iron saddles supported on steel beams fastened to the building columns.

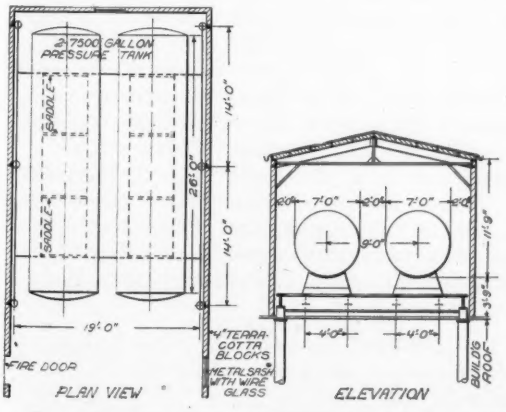


FIG. 5. PRESSURE TANK SUPPORTS AND TANK HOUSE

The construction of the shell is based on a formula where the thickness of plate $= 8 P R \div S$, in which P is the working pressure; R is the internal radius of shell, and S the tensile strength of plates; 8 is a constant corresponding to the quotient found by dividing the factor of safety by the value of riveted joints. The heads, however, are made ⅛ in. thicker than the shell for this diameter tank. The longitudinal joints are triple riveted and placed well below the water line, while the circular seams are single riveted. An 11 by 15-in. manhole with plate and crab, to allow for easy access to the inside of tanks, and reinforced outlets for the required piping, are also provided.

The gravity tank, 4 pressure tanks, pent house and all structural steel supports as above described were furnished and installed under a contract of $8700, exclusive of piping connections.

(To be continued.)

Air Receiver Fires and Explosions

By Frank Richards

"HOW does oily waste accumulate in an air receiver, and what steps should be taken to prevent this accumulation? If an air receiver with an accumulation of oily waste is liable to take fire if allowed to get hot, what steps should be taken to prevent its getting hot?"

"How can cylinder oil be prevented from accumulating on the top of water in an air receiver, I read that 'When the water is drawn off, the oil will be deposited on the inner surfaces of the receiver and will be in suitable condition to evaporate and cause an explosion of great violence.' We blow out our air receiver every time the water gage shows a certain accumulation; should we do it oftener?"

It is not possible with few words to dispose of all the matters suggested by these letters for discussion. One of the earliest and most persistent of air compression troubles is that resulting from the use of lubricating oil in the cylinders. This oil cannot remain where it is functionally employed, but is carried away a little at a time by the compressed air, and it naturally accumulates in the receiver and the pipes.

Drawing off, or blowing off, the water in the receiver —and often there is very little water accumulating there—does not generally get rid of the oil, which clings to, and cakes onto, the bottom sides of the receiver and all along the pipes. This oil has been exposed to high temperature in the act of compression, and generally all of it which could be volatilized at the highest temperature reached has been carried along by the air, and what remains is semi-solid, black and sticky.

The only way to get rid of it when once deposited must be by mechanical means such as actual scraping of the surfaces, so that air receivers would seem to require manholes rather more than steam boilers do, but it is not generally the fashion to provide them. By the way, if anyone is to enter an air receiver for the purpose of scraping and cleaning it, the respirable condition of the air within should first be assured.

In the course of time, if oil is used "liberally" in the cylinders, and if nothing else is done about it, the accumulation of this gummy and highly combustible material may become quite thick, and then it becomes only a question of time as to when it will take fire. Such fires have been so frequent, the cases of air receivers

becoming red hot, or nearly so, have been so numerous that no one has thought it worth while to keep a record of them.

What can cause the ignition of the oily deposit in the air receiver may seem quite puzzling at first, but there are ways to account for it. It may be thought, for instance, that the actual temperature reached in the single act of compression is not sufficient to cause it, but it certainly comes quite near it in some cases. Single-stage compressors in the olden time, were often worked up to 100 lb. gage, and the receiver fires were frequent.

Published tables assume, for convenience, the temperature of the intake air to be 60 deg. F., and the temperature of the air when compressed to 100 lb. is 485 deg. As a matter of fact, the air is heated more or less in entering the cylinder, so that when compression begins, even with intake air nominally at 60 deg., the actual temperature of the air at the beginning of the compression is probably not less than 100 deg., and then the terminal temperature after the compression would be 550 deg.

I have been unable to find any authoritative tabulated statement of the temperatures of spontaneous ignition for the different oil, although it would be a comparatively simple matter to experimentally obtain the necessary data.

If spontaneous ignitions of oil can occur and do occur in the open atmosphere at temperatures which are reached or closely approximated in adiabatic single stage compression, it is safe to expect that such ignitions should occur at lower temperatures when the compression concentrates 6 or 8 times the quantity of air, and 6 or 8 times the quantity of its oxygen constituent, at every point of contact with the oily deposit.

It is proper here also to suggest the possibilities of spontaneous ignition at much lower temperatures than here spoken of where oil is intimately mixed with other materials.

We are not always quite so careful as we should be —often quite the reverse—about screening and guarding the air intake, and dust is often carried by the air in such quantities as to form a considerable aggregate. This dust collects and mingles more or less with oil which accumulates in the receiver and, not being disturbed when once deposited, the combination, if of the right materials, may easily generate heat sufficient to cause ignition independently of the heat due to the compression. To ignite the oil surfaces, it is only necessary to have a fiery glow, and then a flame, at a single point to have the fire immediately spread rapidly and burn fiercely if the compressor is running. Such fire must soon smother itself if the compressor ceases to supply and circulate fresh air.

If the conditions here suggested are permitted to exist, as leading to these ignitions of the oily deposit, the receiver should be strong enough to stand the working pressure even when thus heated by sudden internal combustion, and it may be said that generally air receivers are so strong that pressure explosions from this source are quite infrequent as compared with the numbers of internal fires that occur. When a receiver fire is discovered, by the sudden heating of the receiver or otherwise, the compressor should be stopped at once to check the supply of fresh air.

When we are informed of the conditions causing or preceding these air receiver fires, it would seem to be a simple matter to avoid them. Stage compression should be insisted upon, with efficient intercooling and aftercooling. This would make the high temperatures impossible and would at the same time reduce the lubricant requirements. Some astonishing records have been made of minimum consumption of lubricating oil at Panama and elsewhere, and air receiver fires have been unknown where these conditions have prevailed.

This is not all of the story about air receiver explosion. There are 2 very different types of explosions and one definition of the word does not satisfactorily cover them both. There is the explosion which takes place when the only pressure present is the regular gage pressure, perhaps slightly increased for the time, but due entirely to the mechanical compression of the air, and when the receiver or the piping is at the moment not strong enough to withstand this pressure, and then there is a much more destructive explosion caused by a sudden and enormous increase of pressure caused by the ignition of an explosive mixture of some volatile constituents of the oil with the air. The pressures resulting from explosions of this character are comparable with those resulting from the explosions of gunpowder, and the results are correspondingly severe. It is especially for the avoidance of explosions of this type that it is recommended that the oil used shall have as high a flashpoint as possible, which means that the more volatile constituents of the oil shall have been already eliminated.

It is a fortunate circumstance that to form a mixture which shall be destructively explosive the proportions of air and of oil vapor must be within certain quite narrow limits. Thus in gasoline engine practice it has been found that the explosive range of mixture is between 2 to 5 per cent of gasoline vapor and 98 to 95 per cent of air. Nevertheless such explosive mixtures do form in compressed air receivers, or more frequently in the pipes leading from them, and such mixtures are sometimes ignited with explosive effect. The ignition may come from the receiver taking fire as previously explained and then the flames being carried along with the air until a point is reached where the explosion proportions of mixture exist.

It seems to be quite certain that if due precautions are taken to prevent accumulations of oily residue and dirt, and if high temperatures are avoided in compression, as economy itself would dictate, neither fires nor explosions will occur.—Compressed Air Magazine.

In hand-fired furnaces the grate surface amounts to the horizontal dimensions of the furnace, side wall to side wall, front wall to bridge. With the automatic stoker the term becomes more or less anomalous, since part of the surface may be used exclusively for coking, and the grates may not be horizontal; and part of the grates may be used only for accumulating clinker and ash. With underfeed stokers, coal is not burned on the grates to any appreciable extent. The term is useful for comparison, if the projected area of the furnace is used in each case. Pigott.

For the Inspectors' Convenience

By Thomas Grimes

On a recent visit to a number of plants in Pennsylvania, Northern New York and Canada a number of incidents occurred, some of which will perhaps be of interest to the readers of Practical Engineer.

My work had to do particularly with the boilers, and the engineers I found were, as a rule, keenly alive to the present tendency for better equipment in recording instruments in the boiler room.

One of the courtesies that is extended to the inspector in many of the plants, is what the men are pleased to call "The Trolley." It is a board about 8 in. wide and 4 ft. long with a wheel about 3 in. in diameter near each corner. The board is put into the manhole under the tubes of a horizontal tubular boiler to be inspected or cleaned and a man lying on it can joy-ride back and forth clear of the wet shell plates and without straining and pulling.

Another thing that impressed me was an electric fan placed in front of the manhole. At one place notice of my coming had not been sent down to the engineer until about an hour before I arrived. The boiler had been out of service for a week or more, but the water had remained in it. With a boiler under steam on each side and a leaky stop valve on the boiler to be examined, it was a pretty warm proposition. The engineer sized up the situation quickly and bidding me to wait a few moments, started for the office. He returned shortly with a desk fan under his arm. The fan was started and placed a few inches in front of the manhole and in less than 5 min. the boiler was in condition to enter.

At another plant, a new battery of 4 boilers had been in service about a week. The boilers were equipped with CO_2 recorders, draft gages and a nonreturn valve in each steam outlet. With the master mechanic we went to the fire-room, talking on the way about the new boilers and the equipment. To him the nonreturn valves did not appeal and as we entered the boiler room, cleaning fires under one boiler had just started. The nonreturn valve closed and the pointer on the pressure gage dropped back gradually until, when the cleaning was completed, a drop of 10 lb. was shown.

"There," said the master mechanic, "that boiler has been off the line all the time the fire was being cleaned and the other 3 had to swing the load. Without the nonreturn valve, the pressure would have stayed right up with the rest of the battery."

I had to break the news to him gently, but he was finally convinced that without a nonreturn valve the 3 boilers would have to carry, not only the whole load, but would, in addition, have the fourth boiler hanging onto them. When we parted, he had reversed his opinion of nonreturn valves.

One of the curiosities met with was a full grown piano in an engine room. Upon inquiry I learned that a singing club made up of employes of the factory assembled there one evening each week for rehearsal. The engine room is a spacious one and well suited for the purpose. Assurance was given me by the engineer that the piano was not a part of the equipment of the power plant and it was not part of his duty to keep the instrument in tune.

Back Pressure

By A. Monia

Too little consideration is usually given by engineers to the question of back pressure. Yet this subject is worth all the attention which can be bestowed upon it; for back pressure costs money—and lots of it. For instance, we will assume that we have a 160-hp. plant. The actual cost of the back pressure will depend upon the size of the cylinder and the speed of the piston. It will be readily understood that, for a given power, the speed of the piston must increase as the sectional area of the cylinder diminishes, and if the piston speed remains the same, and an earlier cutoff is obtained, the cylinder must be larger.

We will take an engine of the slide valve type, with a cylinder 12 in. in diameter and a stroke of 18 in., running at 125 r.p.m. Taking 4/5 of the stroke, or that portion of the return before compression begins, as the effective part of the back pressure, we will have the piston moving 125 times $2\frac{1}{3}$ ft., or 292 ft. per min. As the area of the piston is 113 sq. in., we have the piston exerting a power of 292×113, or 32,996 ft.-lb. of work per minute for each pound of back pressure upon the engine. In other words, each pound of back pressure takes off 1 hp. from the effectiveness of the machine, or adds 1 hp. to the constant load.

We are doing, then, one horsepower of useless work. On an economical production of steam, with an evaporation of 10 lb. of water per pound of coal, and using only 32 lb. of water per horsepower per hour, we have a waste of 32 lb. of coal per day of 10 hr., or 5 tons a year, costing $20. As this cost increases directly with the pressure, it will cost $100 a year to support a back pressure of 5 lb. No account is here taken of water charges, which will also be quite an expense in cases where the water is taken from city water works.

It must be remembered, also, that this expense increases with the size of the engine, and for a cylinder 20 in. in diameter would be very high.

Attention of the Bureau of Standards, Department of Commerce, has been directed to the failure and deterioration of fusible tin boiler plugs in service. In some cases such plugs have failed to melt and so give warning of dangerous boiler conditions, and investigation has shown that the tin filling in these cases had become oxidized to tin oxide (SnO_2), which has a melting point above 2900 deg. F.

About 1050 plugs, of which 100 were plugs which had been in service, were obtained and subjected to examination. Lead and zinc are found to be the principal impurities in tin plug fillings, and since all "failed" plugs contained these or other impurities the conclusion is reached that if these impurities are eliminated by strict specifications and inspection, which will allow only admittedly superior qualities of tin, such as Banca and some others, the danger of failures of these plugs will no longer exist. Directions are given for the testing of the purity of the tin in such plugs.

Copies of the report upon this investigation, Technologic Paper No. 53, may be obtained without charge by interested parties upon application to the Bureau of Standards, Washington, D. C.

Electrical Machinery and Appliances

For Generating, Transmitting and Using Current

Notes on Electric Power Development*

By E. M. Herr

THE great development of electric power and its wide distribution and use in all kinds of service is largely due to the possibility of advantageously concentrating, in one central station, engines producing economically enormous amounts of this force, which is then cheaply and easily distributed over a great area and subdivided as minutely or in as large quantities as desired without great loss.

Prior to the development of the generation and transmission of electricity in large quantities, the prime mover, then consisting almost entirely of reciprocating steam engines, had to be brought to its work or the transmission of its power by means of belts or shafting and gears, at best confined to short distances, and accompanied by large loss of power. In mill work each load had its engine and the size of the engine was, of course, limited to the load available at that particular place.

Due largely to the wonderful development in the steam turbine and its direct-connected electric generator, and the remarkably flexible, efficient and easy distribution of electricity, we are on the eve of a notable change in the utilization of electric power.

First—The modern steam turbo-generator makes it possible to concentrate enormous amounts of power generation in one place.

Second—This makes possible and advantageous large individual generating units. The growth in the capacity of generators has really been enormous, made possible by the steam turbine.

Third—Electricity can be transmitted long distances in large or small quantities and its characteristics changed at will, all with small losses and at comparatively low cost.

Previous to 1900 the reciprocating engine driving engine-type generators was used almost exclusively—some tremendous units from the physical standpoint being used, as for instance the 7000-kw. engine-type generators installed by the Interborough Co. of New York for operation of the elevated railway trains. The generators, connected directly to huge Corliss-type engines, were 43 ft. high and compelled the manufacturers to install in a new shop a traveling crane, set unusually high, to handle them. In order that they could be shipped, these machines were so designed that they could be divided into several parts, each the limit of transportation on a large capacity freight car.

About this time steam turbines began to make headway as prime movers. I happened then to be in charge of the works of the Westinghouse Air Brake Co., and had the privilege of purchasing and installing in the power house of the company the first direct-connected turbo-generator ever installed in this country. This machine was of 500 hp., built by the Westinghouse Machine Co., and is still in service.

Soon 1000 to 3000-kw. machines were developed, and even sizes up to 5000 kw., but this was then looked upon as extremely large, and perhaps an abnormal size.

In the development of these turbo-generator units, previous experience in the construction of engines and generators was set aside and designers had to grope their way along until they could accumulate enough experience to undertake bigger things.

The advance was steady and continuous, so that, by 1906, units of capacities equal to the largest engine-type generators had already been built.

With increased experience the advance in size has continued until at the present time units of 30,000 to 35,000 kw. are in operation, and even much larger sizes, up to 50,000 to 60,000 kw. are contemplated. Apparently the upper limit will depend upon the total concentration of power permissible in single units.

Increase in the size of power-generating stations has kept pace with or gone beyond the increase of power in individual generating units. The capacity of steam boilers with modern stokers and forced draft has been wonderfully increased, while the efficiency of the turbine has also been raised greatly by the use of highly superheated high-pressure steam and the modern high-vacuum condenser.

All of this development has led to the reconstruction of power stations equipped with machinery still not old and in condition as good as new. Thus, 4 of the large Interborough 7000-kw. engine-type units, above referred to, still as good as new, have recently been replaced by 3 30,000-kw. turbo-generator units. These new units produce electrical power with a steam consumption of 8 lb. per hp.-hr. against about 13 lb. per hp.-hr. for the old units with reciprocating engines—that is, 90,000 kw. of engine and generator capacity goes into the space occupied formerly by 28,000 kw. and by the use of new stokers, some changes in draft and the addition of superheaters, the same boilers furnish steam for 90,000 kw. that formerly supplied but 28,000 kw. This enables over 3 times the amount of power to be generated in the same space and at a much lower cost.

The growth in size of electric power stations results not only in economy in their operation but also leads to

*From a paper presented at a meeting of the Railway Club of Pittsburgh.

the development and use of protective and safe-guarding apparatus. Many new problems in the control of the enormous amounts of energy distributed have arisen, as well as other problems in the safeguarding and protecting of the generating, regulating and distributing apparatus used. Thus, a short-circuit on a 100,000-kw. power station may bring about conditions so severe as to be beyond the limitations of any known switching or protective apparatus. Such a short-circuit for a moment may correspond to millions of horsepower. Engines and generators may be wrecked, switchboards ruined, disastrous fires started and cables and feeders burnt. In order to prevent such occurrences, protective apparatus had to be and was developed to more than keep pace with that of power machinery, so that now in a large station very large amounts of money may be expended in protective apparatus.

Among the large users of electric power are the modern steel mills. Here very large motors are used. Where ordinary mills use motors of hundreds of horsepower, steel mills require them of thousands of horsepower. Motors have been installed in some mills which can develop 8000 to 10,000 hp. for hours at a time. In some cases these motors are designed to take the swings of from 10,000 to 20,000 hp. for short periods, and can reverse from full speed in one direction to full speed in the opposite in from 5 to 10 sec.

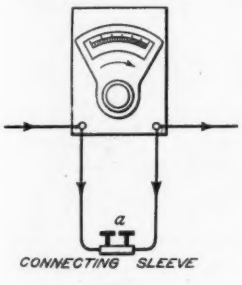


FIG. 1.

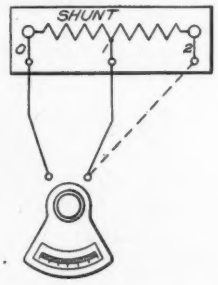


FIG. 2.

FIG. 1. SHUNTING AMMETER TO ALLOW INSTRUMENT TO MEASURE CURRENTS EXCEEDING ITS RANGE

FIG. 2. MILLI-VOLTMETER AND ADJUSTABLE SHUNT

The induction motor has not itself the ideal characteristics for many kinds of steel-mill work, but its adaptability for large units appear to outweigh all disadvantages in most cases. In the reversing mill, its advantages outweigh its disadvantages so that here it is simply used as a prime mover for operating more suitable types of generators and motors. In this case the induction motor drives a large direct-current generator, together with a flywheel attached to it, for carrying the fluctuations in load. This direct-current generator operates the roll motors.

The regulating properties of this combination are such that while the power for driving and reversing the rolls may vary from nothing to 10,000 or even 20,000 hp., the induction motor driving the set will take up an approximately constant load from the supply system.

At light load the induction motor develops power which is stored in the flywheel by speeding it up, while at peak load the flywheel gives up this stored energy in parallel with the driving motor. Thus, this reversing mill work, while extremely violent in itself, yet represents a fairly easy load for the power plant.

Practical Experience in the Operation of Electrical Machinery

WRONG SHUNT RATIO; REPULSION MOTOR TROUBLE. BY E. C. PARHAM

FIGURE 1 illustrates a method of increasing the capacity of an ammeter so that it can be used to measure currents that exceed its range. The largest copper wire that can be passed through the terminals is drawn through them forming a loop in parallel with the meter. The meter and wire are then used as a single unit, and the value of the current indicated by the meter depends upon the loop length, which can be varied.

Using a steady source of current, the calibration of the meter and shunt is carried out as follows: It is desired to read 225 amp. on a 100-amp. ammeter, for example: With only the meter in circuit, adjust the current to 75 amp.; then close the loop through the connector, tightening the screws, and vary the loop length (by drawing one end through a meter terminal) until the reading is 25 amp. (Each time that an adjustment is made the binding-post screw that is loosened for drawing through the wire must be tightened.) A current of 75 amp. still flows; but, as the meter carries only ⅓ of the current, the meter reading must be multiplied by 3 in order to obtain the value of the current in the circuit. With an adjustment for example such that the closing of the loop reduces the meter reading to ½, each reading must

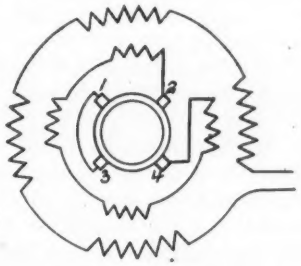


FIG. 3. INTERNAL CONNECTIONS OF SINGLE-PHASE REPULSION-INDUCTION MOTOR

be multiplied by 2 in order to get the total current flowing in the circuit.

Station ammeters and shunts are connected in this manner (the meter carrying only a small part of the current) but the dial is marked as if the meter carried all of the current. In portable work, milli-voltmeters are used in conjunction with standard shunts. Such sets have a stated maximum capacity and several taps may be brought out of the shunt as indicated in Fig. 2. The multiplying factor to be used depends upon the tap that is employed. Assuming that tap 1 is so chosen that the meter reads 100 divisions when the current is 100 amp., the meter then is direct reading and no multiplying factor for the reading should be used. If another tap, for example tap 2, includes twice as much of the resistance of the shunt as tap 1, a line current of 100 amp. will deflect the needle through 200 divisions, and with this connection the actual current will then be but half of that indicated on the meter.

An operator called in an inspector because an exciter apparently was taking about twice the amount of cur-

rent that it should and still was unable to furnish sufficient exciting current to its alternator to maintain normal alternating voltage. As is so often the case, the exciter had no switchboard ammeter. The operator was using a milli-voltmeter-shunt combination that he had borrowed. In connecting the milli-voltmeter to the shunt he had used tap 2 instead of tap 1, thereby making the apparent current twice the actual current.

Upon increasing the exciter current, the alternating voltage promptly became normal. Had the tap been one such that the connection would have caused the meter to indicate but half of the current flowing, the result might have been more serious had the operator undertaken to load his exciter according to the indication of the meter.

Repulsion Motor Heating

In fig. 3, showing the internal connections of a single-phase repulsion-induction motor, the field coils brought to the terminals outside of the motor are the main field coils that correspond to the stator coils of an ordinary induction motor. These connect to the supply lines through a suitable switch. In the actual motor, however, they are divided into pairs and the pairs can be connected in series or in parallel, accordingly as the line voltage may be 220 or 440 v. The inner field coils are wound concentrically with the main field coils and are called compensating field coils because they oppose and neutralize the armature reaction, thereby preventing sparking. The compensating field coils are connected to brushes 3 and 4 and their exciting current is due to the rotation of the armature. Since their polarity is the same as that of the main coils and since their effect increases with the armature speed, it is evident that they act to limit the speed at light loads. These carry the current which, being repelled by the main field, causes the armature to rotate.

An operator complained that his repulsion induction motor was heating too much. An ammeter was connected into the stator circuit and it indicated 30 per cent current overload; notwithstanding this overload, the armature speed was about 200 r.p.m. too high. The brushes sparked very little, but both the brushes and the commutator ran hot. These symptoms suggested a reversed compensating field, which proved to be the case.

Upon reversing the compensating brush leads, every sign of sparking disappeared, the speed decreased about 150 r.p.m., the current decreased from 8 to about 2½ amp. (the amount required for the load carried when the motor was connected properly) and the heating lessened correspondingly.—General Electric Review.

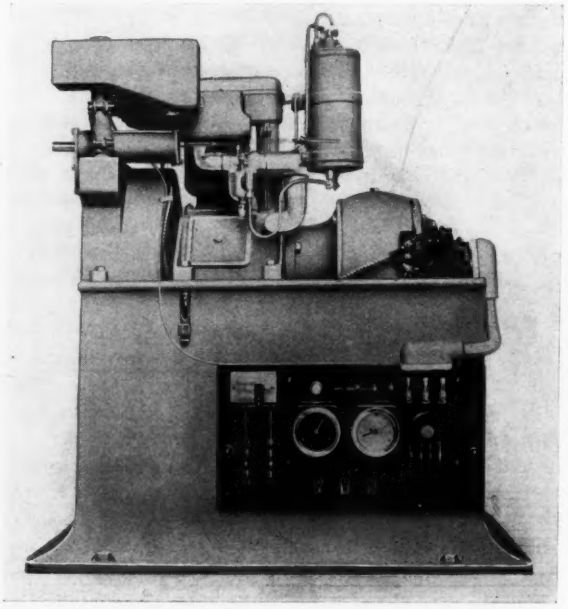
Recognizing that practically every one is certain that higher speed, better work and greater human efficiency are possible in a stable as compared with vibrating building, but that exact data proving this fact are difficult to obtain, the Aberthaw Construction Co., of Boston, Mass., is undertaking an exhaustive investigation in the effort to bring together conclusive evidence. They will greatly appreciate any suggestions or reports of experience that our readers may be able to send to them. These may have to do with any aspect of the case that will assist in the collection of facts or the reaching of conclusions.

Novel Small Home Lighting Plant

By Frank C. Perkins

In the accompanying illustration is shown a compact gasoline-electric lighting equipment for lighting the home, business place or factory and furnishing power for washing machines, sad-irons, vacuum cleaners, sewing machines, cream separators, churns, etc. It is claimed that this small gasoline plant generates current at an approximate cost of 3 cents per kilowatt-hour.

The plant shown is a 50-light unit and consists of a single-cylinder, 4-cycle gasoline engine direct-connected to a 1-kw. 32-v. generator, built as a single unit, together with the radiator for cooling jacket water and electrical controlling devices, all assembled and mounted on a cast-iron sub-base, which also contains the cooling water tank and oil reservoir, each holding a sufficient supply for several months' service without refilling.



GENERAL VIEW OF SMALL GENERATING EQUIPMENT

With the machine is installed an enclosed type 32-v. storage battery, used more for starting and controlling the engine than for actual lighting. All heavy loads are carried by the generator and only 15 per cent of the battery is discharged under any condition, when it is then automatically charged. The use of the battery in connection with the generator assures a uniform voltage and steady light.

When 15 per cent of the battery capacity has been consumed, the engine will automatically start, causing the generator to carry not only any load that may be on the line, but also to charge the battery. With light load the generator carries all of the load, the battery acting simply as a regulator.

A muffler provided for the exhaust makes it possible to install the equipment in the basement of any home without annoyance. With the hand-control, the engine is started by throwing in the main circuit breaker, and it is unnecessary to stop the engine when the battery is fully charged. This feature is taken care of automatically on the switchboard.

A Satisfactory Test Load

By Chas. M. Green

WHILE engaged in the erection of a new power station, I was called upon to conduct a test on the generators, which were rated at 2000 amp., 250 v. The switchboard was, however, not erected, nor was it possible to connect the regular load to the generators in any way. To obtain the necessary load, I built a water rheostat of 4 oil barrels and some No. 12 iron telephone wire wound on sticks and cooled with a 2-in. stream of water. The erectors laughed at my attempt to carry any load with such an arrangement, but I soon proved to them that it would not only carry 2000 amp., but twice that amount.

When the test came on there were, however, no circuit breakers to use and, as I had the job of throwing the load on and off repeatedly and knowing how long an ordinary knife switch would last under such conditions, to say nothing of the man operating, I fixed up 4 single-pole knife switches on a rough bench and nailed the leads to these switches, about 1 ft. apart onto a plank as shown in the accompanying sketch. A No. 14 bare copper wire was then used to join these leads and thereby act as a shunt to the switches. When the signal was given to reduce the load by throwing off a barrel, I would pull

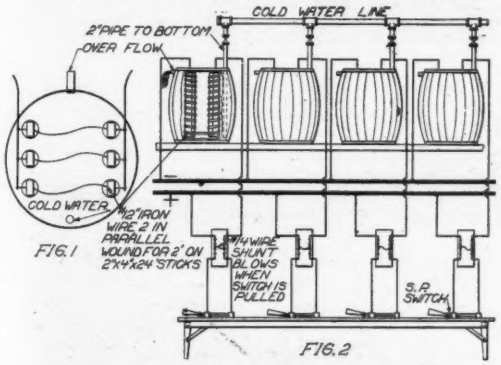

COLD WATER LINE
2" PIPE TO BOTTOM
OVER FLOW
COLD WATER
#12 IRON WIRE 2 IN PARALLEL WOUND FOR 2' ON 2"x4"x24" STICKS
FIG. 1
#14 WIRE SHUNT BLOWS WHEN SWITCH IS PULLED
S.P. SWITCH
FIG. 2

FIG. 1. RHEOSTAT DETAILS SHOWING ARRANGEMENT OF COILS

FIG. 2. ARRANGEMENT OF RHEOSTATS AND CONTROL SWITCHES

the proper switch in perfect safety and without any noticeable arcing. This, of course, threw all of the load onto the shunt of short length of No. 14 wire, which a few seconds after let go and thereby broke the circuit. The men in the engine room had no trouble telling when the circuit opened, as the noise accompanying the blowing of the fuses was much like that of a shot gun.

Report from the U. S. Geological Survey on oil production of the country for 1915 gives the total marketed as 267,400,000 barrels as against 265,762,535 for 1914, an excess of some 1,300,000 barrels. Transporting and refining facilities were, however, overloaded during 1914, so that 1915 has been a year of readjustment so that production has been retarded as far as practicable. John D. Winthrop of the Geological Survey estimates that the total yield for 1915 was some 291,400,000 barrels, the balance not marketed, 24,000,000 barrels, being placed in field storage.

Building the Arrowrock Dam

Some Interesting Parts Played by Electricity in Building the World's Highest Dam. By H. A. Lawson

COULD Benjamin Franklin have seen the effect the little key he tied to a kite had in revolutionizing irrigation project construction, as it has revolutionized almost everything else, he would have witnessed human beings working like ants in a great cavity at night near Boise, Idaho, boring into the very bowels of the mountains under the powerful play of searchlight. They were helping to make a great excavation below the Boise River bed so that the highest dam in the world, the Arrowrock, could be anchored to a solid granite base. His discovery of electricity made it possible to build this dam in record time or in 4 yr. at a cost of $5,000,000. It stands completed today a masterpiece to the engineering profession, and its formal dedication, in which Boise and all Idaho joyfully participated, took place Oct. 4 with proper ceremony. Its construction means the irrigation of an empire, 240,000 acres of land in western Idaho.

A coal mine not being available in 1912 when work on the dam was started, the Reclamation Service engineers in charge, F. E. Weymouth, supervising engineer, C. H. Paul, constructing engineer, and James Munn, superintendent of construction, to whom credit is due for the project and dam building, proceeded to harness the water power going to waste in the Boise River 16 mi. below the dam site, to provide power for the great steam shovels which had to be operated, for other power purposes as well as for lighting. Coal would have been too expensive for this purpose, and the supply was uncertain. Water was plentiful and close at hand.

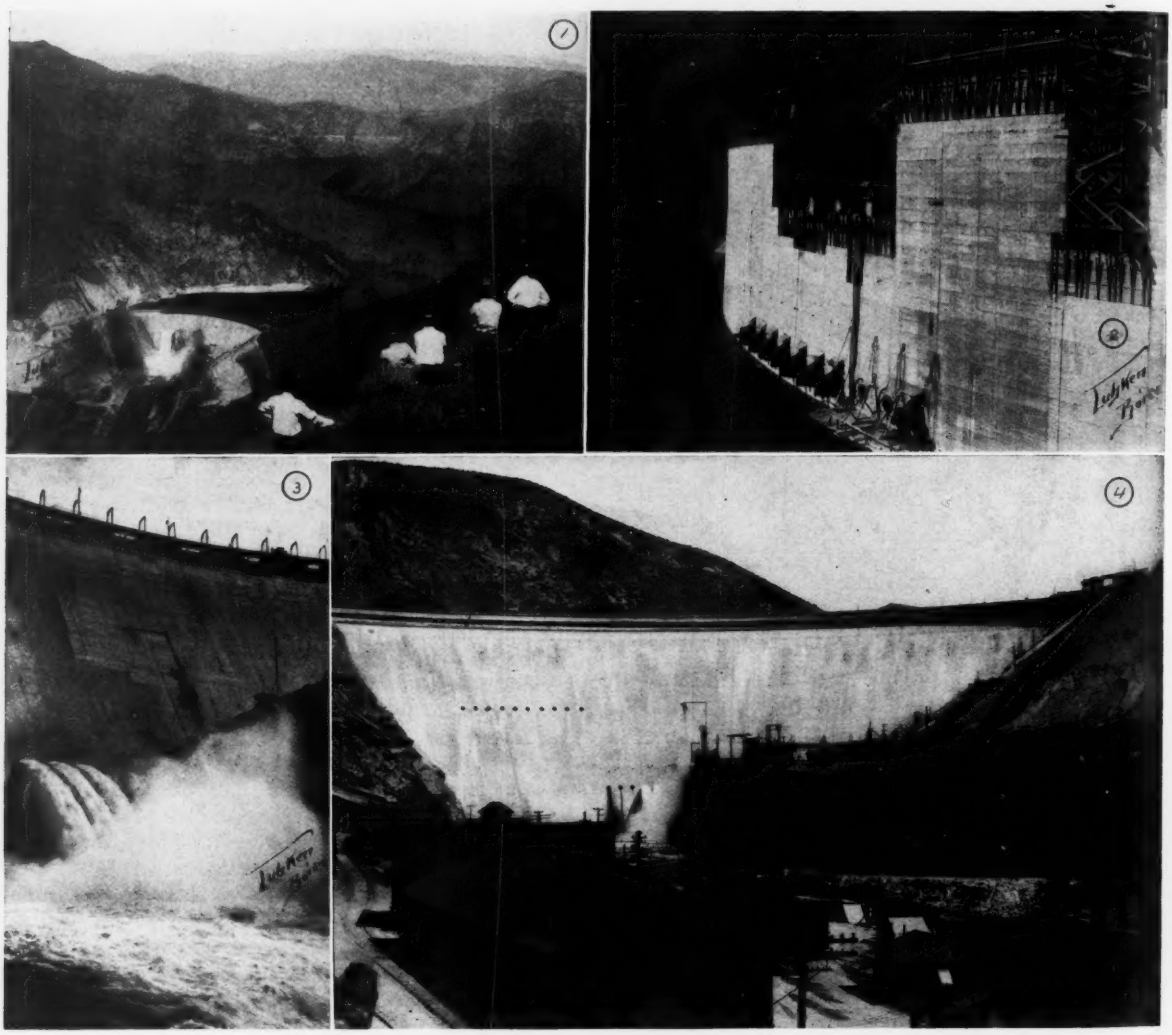
They erected the Boise hydro-electric power plant primarily for construction purposes at what is known as diversion dam, the point where water released from the great dam above is diverted into the main canal leading to the lands of the project 30 and 40 mi. below. The dam and project finished, the electric plant stands a valuable asset for both. It is built of concrete and steel at a point on the river where a 25-ft. fall is secured. It consists of 3 Allis-Chalmers 725-hp. hydraulic turbines, each with direct connections to an EVA generator. Its capacity is from 2500 to 3000 hp. The output is 3-phase, 60-cycle, alternating current at 2300 volts, which is transmitted from the station at 22,000 volts.

Without this power, construction of the dam would have been made doubly difficult. With it the power question, an important one in their construction, was quickly solved. Transmission lines were built both to the dam and to project points. It kept dredges at both places busy for several years. When the problem of building ditches for a drainage district came up, the power from the plant supplied the electric dredges.

A record was made in the dam construction. Credit for the record is largely due to electricity, for with it feeding into powerful searchlights it was possible to keep a night shift on the job, and so well was the light distributed that the men worked as well as in the daytime. Two other shifts preceded the night shift, which went on at 6 o'clock p. m., having had breakfast at 4:30 p. m. From 2 to 3 hr. after they had been at work, the searchlights were turned on. Their powerful rays

carried across the deep canyon, lighting up the cableways, struck the hoppers where the concrete buckets dumped, and played about and on every avenue of occupation. Arc lights were pulled out over the works on cables stretched overhead. Clusters of incandescents, with an arc here and there, lighted up the railway. There were no dark corners within the limits of activity, for the artificial light was apparently as good as Old Sol himself could provide. When it is realized that close to 500 men composed the shift, and had almost as many

The Arrowrock dam stands 348.5 ft. high, 90 ft. of which is below the bed of the river, anchored to solid granite, through which a series of holes were bored to a depth of from 30 to 40 ft., and grouted with concrete under pressure to prevent possible seepage. The river was diverted from its normal channel in which the dam sits into a tunnel put through a cliff. A coffer dam left the river bed dry, and in it were placed 70-ton Atlantic shovels, derricks, hoists, etc. With the assistance of men to operate them and work in the pit, the excavation



VIEWS OF ARROWROCK DAM: 1. BIRD'S-EYE VIEW SHOWING A SECTION OF 18 MI. RESERVOIR ABOVE AND CONSTRUCTION CAMP BELOW. 2. GREAT VALVES 150 FT. ABOVE RIVER BED FOR RELEASE OF STORAGE WATER WHEN NEEDED FOR IRRIGATION. 3. DAM NEARING COMPLETION, WATER POURING THROUGH OUTLETS 4 FT. 4 IN. IN DIAMETER. 4. COMPLETED DAM SHOWING LOG CHUTE AT THE RIGHT.

difficult duties to perform, while danger to life and limb was always possible, the advantage of electrical energy so used can be appreciated. Without abundance of electrical energy for the searchlights, a third shift would have been impossible, and the great dam would not stand completed today. The plant also furnished all the electricity for lighting the town of Arrowrock, which sprung up below the dam and had a population of 1500 people for 4 yr. Today it has practically disappeared.

was gradually sunk down, the grouting took place and the foundation for the towering dam laid 240 ft. wide at the base and 1100 ft. long.

Each day thereafter saw the structure 2000 cu. yd. nearer completion. A line of open holes to catch possible seepage bored just below the holes for grouting, together with grouting holes, was carried up through the dam and connected with galleries built inside of it from which the outlets are operated partly by water pressure and

partly by electricity. In these galleries additional grouting can be carried on deep below the base of the dam if necessary. The thickness of the structure was gradually reduced until at the crest it stands but 16 ft. wide, forming a roadway, guarded on either side by a parapet wall 4 ft. high. Mounted at intervals on this are rows of pedestals crowned with arc lights, power for which is furnished by the electric plant.

To the one side of the dam has been cut a gigantic spillway through a cliff of solid granite. It is 400 ft. long, following the contour of the ground in a direction at right angles with the dam. In flood season water from the reservoir will enter the spillway over the lip mounted on which are specially constructed gates. It will be carried off around the dam and allowed to cascade down the mountain side back into the river. In an extreme flood year, should the spillway be unable to handle the water, the dam is so constructed as to permit it to plunge over its crest, dropping over 250 ft. to the river below. A total of 40,000 second feet of water can rush through this spillway at its normal capacity and could it be harnessed it would develop a vast amount of electrical energy.

To the opposite side of the dam, a concrete log chute has been built to permit the passage of logs from the reservoir to the river below. The estimated stand of timber tributary to the reservoir is 3,000,000,000 ft., valued at $36,000,000. It will take 50 yr. to pass it over the dam. On the same side, should it be deemed advisable to build an additional hydro-electric plant, a tunnel can be bored through the mountain side to tap the reservoir and provide the water to generate as high as 50,000 hp.

The reservoir is 18 mi. long with a maximum depth of 200 ft. Its capacity is 244,300 acre-feet, which if spread one foot deep would cover 360 sq. mi., or it would cover the city of New York, including Manhattan Island, Bronx, Brooklyn, Queens and Richmond to the same depth; cover Chicago with 2 ft. of water; Boston with 8 ft.; the District of Columbia with 5 ft., and the state of Rhode Island with 4 in.

The dam itself weighs over a million tons. If loaded a ton to each 20-ft. wagon, the wagons would reach from San Francisco to New York and double back to Cleveland. The project is located tributary to Boise from 40 to 60 mi. from the dam. Every acre with the exception of about 1000 has been filed on by settlers.

Reminder of Overhauling Time

VALUE OF MAINTAINING DAILY RECORD OF ALL OCCURRENCES DURING BUSY SEASON OF REFRIGERATING PLANT; METHOD OF SELECTING APPARATUS AND MATERIAL TO BE USED. BY A. G. SOLOMON

NOW THAT it is time to do the necessary overhauling, the log book is carefully looked over and notes made to guide in the work. Following are the extracts taken from the log book and show how the overhauling is made an easy job and nothing that is necessary to be attended to will be neglected.

In this plant, the daily reports were carefully kept and all conditions noted for future reference. Material which is to be used was selected by writing to the different manufacturers and getting their catalogs and other literature.

Samples of fittings, discs, packing, gaskets, etc., were obtained and tried out and their merits or defects noted. By this method, the chief engineer knew exactly what he wanted for new equipment, replacements and repairs, and the overhauling was more a pleasure than the dreaded job it is to those who have to jump into it and do not really know what is needed or what is best for certain service. By proper foresight and planning, the material can all be ordered and at the plant when the overhauling begins.

Nothing is left to guess work and it is not a case of "We will see what is needed when we get to it." This important work of putting the plant in good shape for the next season should be laid out in much the same manner as an architect plans the erection of a building.

After the daily reports have been carefully looked over, the following summary is the result. It shows what is to be done and why; what material is needed and the kind recommended.

We know exactly where to get the best furnace brick mason to do the re-lining of the furnaces. A reliable machine shop has been located and their estimate on the work obtained. We have inquired and know that it is, as a rule, cheaper and better to order repair parts from the manufacturers of the machines than to have them made in a local shop.

THE BOILER ROOM

THREE 66-in. by 16-ft. horizontal return tubular boilers; 60 4-in. tubes in each; 2 boiler feed pumps, size 8 by 6 by 8 in.; one feed water heater, open type.

Boiler Number 1.

New tubes needed in top row. Ends of old ones thin from frequent rolling. Order 12 tubes, 4 in. diameter by 16 ft. long, from ——— Boiler Co.

Pop valve leaks. Grind in seat.

Renew pipe work connecting water column to boiler. Use cross fittings and brass plugs in place of tees.

Boiler Number 2.

New cocks for water glass. Old ones have packing nut threads worn out from long use. Size, ¾ in.

New bottom try cock on water column. Broken off through accident and nipple and angle valve now in place. Size, ½ in. Order from ——— & Co.

New water feed valve as the one now in place is only temporary on account of failure. Size, 2 in. Order a ——— valve from ——— Co., as they are highly recommended and can be depended on.

Boiler Number 3.

New furnace lining throughout, also new bridge wall. Investigate the merits of ——— Co., ready to put in furnace lining and arch blocks. If regular fire brick is used, order ——— thousand ——— Co. brick; ——— sacks fire clay; ——— bags cement. Get fire clay and cement from ——— Co.

New set grate bars needed. Duplicate order of April 10 at ——— Grate Co. They are the best obtainable.

Blowoff line needs renewing.

New blowoff valve. Order 2-in. ——— valve from ——— Valve Co.

Set blow back of pop valve as it loses too much steam before closing.

A salesman from the ——— Boiler Tube Cleaner Co. will be here to demonstrate a scale remover. If satisfactory, take up purchase with the Super.

The nonreturn valves on all 3 boilers must be taken apart, cleaned and inspected. The one on boiler 2 sticks slightly and we will put a small cylinder oil cup on it to lubricate the moving parts.

New bolts and gaskets needed in some of the flanges of the main steam header. Have tested sample gasket of the ——— Co. and found it satisfactory. Order 6 of the same for 8-in. flange; 6 each for 6-in. and 4-in. flange.

Boiler Feed Pumps and Feed Lines.

Pump number 1 needs new brass sleeve in east water cylinder. Old one worn through. Order from factory. New pins and bushings in valve gear. Get done at ——— Machine Shop.

Pump Number 2.

Needs complete overhauling. Order new rods, valve stems and set of snap rings for steam pistons from factory. (See name plate on pump). Recommend that trial be given ———'s hot water pump valves and ———'s hydraulic packing. Size of valves 3 by ⅝ by ⅝ in. Size of packing ⅝ in.

Investigate ——— Co. pressure regulator and get price. Feed line has been burst twice during season and several gaskets blown out by over pressure when fireman has closed feed valves. R——— Co. also put out good regulator.

New check valves needed on all 3 boilers. Get ——— Co. check with renewable disc. Get 1 doz. ——— Co. 2-in. disc. Have tried a sample and know they are O. K.

New lubricators needed on both pumps. One ——— Co. cylinder oil pump will do for both pumps as they are in such position that operating arm of oil pump can be shifted from one pump to the other when necessary. (Agent has been here and will call again.)

Feed Water Heater.

Some oil getting into heater from exhaust steam. Old style separator now in use is no good. Have already procured literature and price on ——— Co. oil separator and salesman will call.

Repair float on float valve.

Repair blowoff valve.

See about insulation for heater.

Engine Room

One 50-ton horizontal double-acting ammonia compressor, steam driven.

One air compressor, compound steam and compound air.

Two duplex steam pumps for ammonia condensers.

Ice Machine.

Order one 1-in. ——— Co. steam trap to be used on steam separator of steam line.

Bore out head end steam valve chamber and fit new valve. Estimate received from ——— Machine shop.

Babbit crank brasses on compressor side.

Order from factory one each suction and discharge valve for ammonia compressor.

Turn down ammonia piston rod and babbit and bore out bushing at back end of stuffing box, oil lantern and gland (neat sliding fit). Get done at ——— Machine shop.

Order enough (3½ lb.) ——— Co. special ammonia packing to pack rod once for a trial. Will cost nothing if not a success at end of 30 days.

Write to ——— Co. for information on their ammonia purifier.

Move oil separator on ammonia discharge line from its present position close to compressor to a point in the line as close to condenser as possible. Discharged gas is so hot that oil is not caught. In new position, some of the heat of compression will be taken from ammonia before it reaches separator and the oil will not be so finely atomized.

Insulate liquid lines and receiver, as the engine room is much warmer than the liquid as it leaves the condenser. Recommend ——— Co. insulation.

Install thermometer wells in suction and discharge lines close to compressor, also one in liquid line between liquid receiver and expansion valves.

——— Co. thermometers set in wells preferred to thermometers screwed direct in pipe. In case of breakage, the latter cannot be replaced without pumping out and shutting down.

Condenser Pumps.

Both pumps need complete overhauling; new rods, valve stems, bore out and fit new piston right hand steam cylinder No. 1 pump. Both water cylinders No. 2 pump need new brass sleeves. This repairing will cost almost as much as new pumps, so recommend the installation of one ——— Co. motor driven centrifugal pump. Have sufficient electric power to run this and it will pay for itself in a season owing to its great economy in the use of power. The cost of upkeep, oil and attendance is so small that it need not be considered. One fairly good pump can be made from the 2 old ones and this can be held in reserve. Have notified the salesman and he will call with estimate.

Air Compressor.

Order from factory one full set valves (suction and discharge) for low-pressure air cylinder; also 2 each suction and discharge valves for high-pressure air cylinder.

Give ——— Co. metallic packing a fair trial on high pressure air piston rod. It is guaranteed for 1 yr.

Put new set tubes in air inter-cooler.

Replace old ball and lever safety valve with ——— Co. pop safety valve on high pressure air receiver (2-in. size).

New steam gage on receiver between high and low-pressure steam cylinders. Get from ——— Gage Co.

Babbit crosshead shoes on righ-hand side.

Get repair parts for oil pump from ——— Lubricator Co.

Ammonia Condensers.

Clean scale off coils and paint with ——— Co. condenser paint.

New bolts in all flanges of liquid header.

New babbit disc in all valves that are marked as leaking.

Make some arrangement so that liquid reaching receiver will have same temperature as coldest cooling water. Run liquid line through jacket made of one length of 4-in. pipe provided with caps, glands and water inlet and outlet.

Pack all ammonia valve stems with ——— Co. packing.

Direct Expansion Piping

Steam out all coils in cold storage rooms to remove oil.

Install home made oil traps in lowest point of coils in rooms 1, 4 and 7. These coils block up with oil.

Make one coil out of the 2 in room 5. At present each coil is only 300 ft. long. Expansion valves on such short coils in a cold room have to be set so close that they cannot be properly regulated.

Examine carefully all pipe hangers.

Ammonia in Ice

THE engine room in a certain ice plant was, as usual, on the first floor, the ammonia condensers on the second floor and the reboiler house above them, writes S. J. in Ice. The overflow cooling water from compressor jackets went direct to the feed water heater.

I came on watch one night just after the discharge valve on the machine had been repaired and the machine started. In making my rounds and while passing through the reboiler house, I detected the presence of ammonia fumes. I returned and inspected the condensers, but found nothing wrong, so took it for granted that the fumes came from the ammonia which had escaped while the valves were being changed.

About an hour later, I made another trip to the reboiler room and found the same conditions. Procuring a sheet of litmus paper, I made a more thorough examination of the condensers, but again found no leaks. Returning to the reboiler room, I peered over the end of the reboiler and inhaled deeply. Strong ammonia fumes sent me to the floor quickly. I then examined the water in the ice cans and found it thoroughly saturated with ammonia.

Such an occurrence being unusual, I was at a loss to know what to do to find and remedy the trouble, but after sometime discovered that ammonia was being sent to the boiler by way of the compressor jacket and feed water heater, and consequently it had made a complete cycle, finally reaching the cans. I immediately bypassed the cooling water from compressor jacket to heater and turned in city water, drained distilled water storage tank and then made an effort to cleanse the entire system. After running an hour, I tested the distilled water with litmus paper and still found it strongly saturated. Going to the boiler room and applying litmus paper to the steam line at the gage cock, I again found it.

To make a long story short, I opened the blowoff valve on the boiler slightly, speeded up feed pumps and continued this way the rest of the night. When I went off duty, the system was not entirely free from ammonia, but about 9 a.m. the day man was ready to fill the distilled water tank. I neglected to say that during the night I succeeded in stopping the leak in the compressor head.

After this experience, I made a practice of testing jacket water regularly, but fortunately had no more trouble of this kind.

Ammonia Leaks in Brine Tank

By G. A. Robertson

EVERY refrigerating engineer, no doubt, has frequently surmised as to what should be done, in the event a serious ammonia leak developed in the ice tank. The writer has asked a number of engineers this question, from time to time, and in most cases found the men a little uncertain as to what would be the best thing to do.

An ammonia leak in the brine tank is always a very expensive proposition. There is the loss of ammonia, the brine is frequently so saturated with ammonia that it must be thrown away, the tank must be stripped of ice, causing a considerable delay in the plant output; all such items make deep inroads into the year's profit of the plant.

As a general thing, these losses can hardly be avoided, but can be held to a minimum by prompt and judicious action on the part of the engineer. The writer would suggest the following method in the event of a serious ammonia leak in the brine tank. When the leak is discovered (if it is a serious leak it can be detected by a roaring sound in the tank) the engineer should at once observe his back pressure gage. Should the gage pointer be near the zero mark, shut down the machine and make the necessary changes and start pumping air into the tank coils. As soon as the gage indicates 5 to 10 lb. pressure, close the expansion valves. Should the gage at first sight indicate a 10 lb. pressure or more, close the expansion valves and let the machine run until the pressure drops below the 10 lb. mark. Tap the gage gently from time to time to make sure it is not sticking; also have a man stationed on the tank near the leak, to make sure the blowing and roaring sound does not stop. Keep an air pressure on the tank coils until the brine is removed from the tank, and is brought below the leak in stripping the tank of the ice. In other words, keep the brine from getting into the coils; for should much brine get into the system, there will be trouble and expense too numerous to mention.—Refrigerating World.

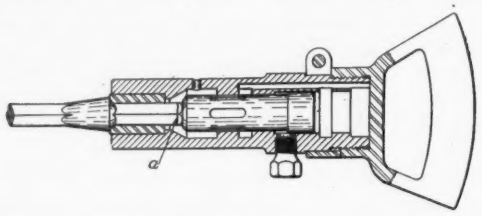
U. S. Civil Service Commission announces an examination, Feb. 15, 1916, for topographic and subsurface draftsman, to fill a vacancy at $4.48 to $5.04 a day, in the Navy Yard, Philadelphia, Pa. Applicants must have had not less than 4 yr. experience in engineering and surveying. Of this not less than 6 mo. must have been special work in underground survey work. A technical education in engineering will be equivalent to the general experience required. Age, 21 yr. or over. Apply for Form, 1312, stating the title, Topographic and Subsurface Draftsman (Male), to U. S. Civil Service Commission, Washington, D. C.

Some Pneumatic Tool Troubles

CAUSES AND REMEDIES OF TROUBLES WITH PNEUMATIC TOOLS. BY H. A. JAHNKE

A PNEUMATIC hammer drill was brought to the shop for repairs, as it would not run. In taking the hammer apart, a small hexagonal piece of steel was found lodged next to the piston and it was thought at that time that it came from some part of the hammer drill; but no place could be found where this had broken off, so the hammer was put together again and the air hose connected, when the hammer would run for a short time, then stop. This was a puzzle to me, as after the hammer would stop and the air was shut off, then turned on again, the hammer would run for a short time, then stop again, when the same performance had to be repeated by opening and closing the air hose cock.

Then I examined the hammer and the tool used more closely, when I found the cause of the trouble. The hexagonal piece of steel that I had removed from the hammer had broken off the shank of the tool, which in turn made the shank too short, making it impossible for the hammer to run right. At A is shown where the



CROSS SECTION OF HAMMER DRILL SHOWING LOCATION OF BREAK

hexagonal piece of steel broke off the shank, which was about ¼ in. thick and looked as if it had been sawed off, which I believe was because the steel in the tool must have been quite hard.

CAUSE OF HAMMER PISTON BREAKING

I HAVE FOUND that many pistons are broken in pneumatic hammers, especially on hammers that are used for chipping, stone cutting, etc., which is due, in most cases, to the fact that the shank on the tool used is not square on the end where the hammer piston strikes. Where the top of shank is out of square or round, the blow of the hammer piston is not distributed over the whole striking surface of the piston as it should be, but will strike only at a certain point of the shank with the result that the striking end of the piston is fractured. Quite often, I have seen pistons broken due to this cause. To avoid trouble of this kind the striking end of the tool shank should always be kept square. This will save expense and trouble. Another point which will cause the piston to fracture is where some pneumatic hammers have a bushing on the end where the tool shank passes through. This bushing gets worn on one side, in time, due to the operator's holding the tool always in one position, when it will be impossible to hold the tool square so the hammer piston will have a full bearing on the tool shank when striking, but will merely give a glancing blow, which may cause the piston to break.

To save trouble, these bushings should be renewed before they become excessively worn.

CARE OF PNEUMATIC TOOLS

I HAVE FOUND in my experience with these tools that about the most trouble we have with them is due to lack of attention. I have received hammers for repairs that would not run at all, but upon taking them apart found the air passages nearly closed up by gummy oil or some other matter. Another point which will cause much annoyance to air tool users is that the internal working parts of pneumatic tools are highly polished as well as accurately fitted, therefore they easily rust from dampness as well as the moisture in the air used in the tools. For this reason, no tools should be laid away for any length of time without first dropping a little oil into the air inlet hole, then running the tool for a short time so as to give the internal working parts a coat of oil. If this is not done and tools are idle for a few days, they may rust badly, then if the tools are to be used again they will not work or the piston and barrel will be cut. I have seen tools come to the shop for repairs where it was quite hard to remove the piston from the barrel, which was due to rust. After the tool had lain idle a few days the rust had to be removed with a piece of fine emery cloth from the piston and barrel.

Therefore, preventing your tools from rusting is very important and should be given attention. I have received tools for repair which the operator said were worn out and had lost all their power, but in taking them apart in most cases it was found that the trouble was in the air passages being nearly closed up or the piston and barrel being rusted. To overcome this trouble in our plant, we have a covered tank filled with kerosene into which the tools are placed at night or when they are not in use. In this way, rusting is prevented and the kerosene also cuts and softens the gummy oil and other matter in the air passages. Then when the tools are to be used they are connected with the hose and thoroughly blown out, then after being disconnected and oiled they are ready to run.

Another bad mistake some air tool users make is to use the wrong oil, which may gum and close up the air passages. To avoid this trouble, use oil made especially for this purpose.

The above applies particularly to pneumatic hammer drills, chipping and stone cutting hammers, etc., but no doubt applies to many other pneumatic tools and machinery.

Small Changes in Coal for 1915

THE production of bituminous coal and anthracite in 1915 is estimated to have increased between 4 and 5 million short tons, or less than 1 per cent. The quantity of bituminous coal mined increased about 6½ million tons and that of anthracite decreased over 2 million short tons. Owing mainly to steady demands for export coal and for coke for steel making, the output in Pennsylvania, West Virginia, Kentucky, and Alabama increased over last year, but little change is recorded in other eastern States. The region west of Ohio, including the Mississippi Valley, shows a general decrease, Colorado being the only western State to show betterment.

Connected with the coke industry was the completion during the last summer of a number of large plants

for the recovery of benzo from byproduct cove-oven gas. This gives the United States its first output of this material, so important as a raw material in the manufacture of high explosives and chemical dyes, and the amount of this product will be reported later.

Preliminary estimates of the total output of petroleum in the United States in 1915 indicate a slight increase over the corresponding output in 1914. It is believed that the total petroleum yield of the United States in 1915 amounted to 291,400,000 bbl., of which quantity it is also estimated that 267,400,000 bbl. was marketed and 24,000,000 bbl. placed in producers' field tankage during the year.

Air Compressor Explosions

NUMEROUS accidents occur in connection with the use of high-pressure air, and explosions of various parts of the apparatus are likely to be most serious in their results, both with regard to property damage and personal injury. Air compressor explosions, considered in proportion to the number of compressors in use, are perhaps even more frequent than explosions of steam boilers; and all possible precautions should therefore be taken to safeguard the compressing apparatus, by designing and constructing the various parts with suitable factors of safety, by providing safety valves, and by operating the installations in an intelligent and careful manner.

Air compressor explosions are caused by over pressure. This excess pressure may be due to the failure of the safety valve to operate properly, or it may be caused by the spontaneous ignition of explosive gases of some kind within the compressor cylinders, or in the pipe lines or receivers. Lubricating oil is the only combustible substance that can be present in the cylinders of an air compressor under normal conditions, and it is therefore responsible for the explosions that take place in them. Oil is combustible in its liquid state, or when vaporized, or when partially carbonized and deposited in solid form upon the walls of the compressor cylinders, or upon the inner surfaces of the piping.

There is reason to believe that there is little danger to be feared from explosions of the oil when it is in the form of either liquid or vapor, because during the normal operation of the compressors it is hardly possible for oil to accumulate, in either of these forms, in sufficient amount to cause such explosions. We must therefore look, for the cause of the trouble, to the soot-like deposits that are formed when a poor grade of oil is used, or when the oil is fed in excessive quantities.

Chemical analysis shows that a combination of one part of finely-divided carbon and 11½ parts of air, both by weight, forms a mixture with explosive possibilities. One pound of carbon gives off 14,500 B.t.u. when burned, and by the explosion of a mixture such as we have just assumed, there would be 979 units of heat liberated, per cubic yard of air. Naturally all this heat could not be expended in the production of mechanical energy, but we may perhaps assume that 10 per cent of it could be so expended. That is, 98 B.t.u., or over 76,000 ft. lb. of mechanical energy, would be available for every cubic yard of air.

Finely-divided carbon ordinarily ignites at a temperature of about 600 deg. F., but if it is subjected to continuous heat and pressure the igniting point is much lower. It is therefore highly important to keep the cylinder temperature low, and this may be done by providing adequate water jacketing, and by keeping the water circulating freely and continuously.

Carbon is usually the result of an excessive oil supply, or of using oil of poor quality for lubricating the air cylinders. An excess of oil often causes the ports and valves to become obstructed by carbon deposits, and this is likely to bring about an increased temperature in the cylinder. Experience shows that from 1 to 3 drops of oil every 5 min. is sufficient to lubricate cylinders of ordinary size. Mineral oil of medium viscosity is to be preferred, and it should be free from bituminous and other foreign matter.

Air cylinders should be washed out frequently with soft soap and water, or with a solution of caustic soda or caustic potash, to remove slight accumulations of carbon deposit. Under no circumstances, however, should kerosene, gasoline, or other similar inflammable liquids or substances be used for cleaning purposes. If care is taken to prevent carbon deposits, and an adequate and constant circulation of cooling water is maintained, and safety valves are connected to the cylinders, explosions of this part of the equipment will be of very infrequent occurrence.

Explosions of the air receivers of compressor installations are more frequent than those of the air cylinders. In many cases receiver tanks are installed that were never designed for such service. Sometimes, also, no safety valves are provided, and the safety element seems to be entirely neglected throughout the entire installation.

In order to remove oil that may accumulate in a receiver, a flange may be riveted to the receiver at its lowest point. A 4-in. nipple, about 1 ft. long, may then be screwed into the flange, and this may be bushed to receive a stop-cock. A pocket or trap is thus formed, in which the oil will collect and from which it may be blown by opening the cock. A manhole or handhole should be located in each receiver, to afford adequate facilities for cleaning.

Explosions occur frequently in the air lines or pipes because of defective air valves which permit the compressed air to return to the cylinder. As the air is recompressed in consequence of such leakage, the temperature constantly increases until it reaches a point high enough to vaporize the oil that has accumulated on the interior of the pipes, or even to ignite the oil vapor, and thus cause an explosion.

Accidents are likely to occur if open lights are placed in proximity to a cylinder head that is being removed, and under no circumstances should lighted matches, candles, kerosene lamps or other open-flame lights be used. Serious explosions have been caused by escaping gases when removing cylinder heads, these gases resulting from the use of kerosene or gasoline for cleaning the cylinders, or from vaporized lubricating oil.

If it becomes necessary to replace piston rings, or to do other work in the cylinders, the compressor should be shut down some time in advance, to allow it to cool off thoroughly before the work is begun.

It is highly desirable to use an aftercooler and a separator. The purpose of the aftercooler is to condense the moisture and oil so that these will be retained by the separator, from which they may be removed. It also tends to keep the temperature of the air low, so that ignition cannot take place in the pipes or receiver. *Both* of these devices should be used, as they work independently of each other.

The valves should be regularly inspected and tested, and the receiver and pipes into which the compressor discharges should be blown out periodically to remove any oil and water that may have accumulated.

It is extremely important that the discharge valves be regularly inspected and cleaned, because if they stick, hot, compressed air will return into the air cylinders, thereby increasing the temperature of the air to such a point that ignition of the lubricating oil may take place on the next stroke.

Recording thermometers, placed on the air lines close to the compressors, are highly to be recommended, for showing the temperature of the outgoing air. Automatic electrical emergency shutdown devices, operated by the thermometers, are also in use in some plants, and these are also of great value, but they must be given careful attention and be tested frequently to make sure that they are working properly. Another effective warning device consists in a gong which sounds whenever the temperature of the outgoing air rises sufficiently to close an electrical contact on the thermometer or thermostat.

Fusible signal plugs have been devised for use with air compressors, and these should be generally adopted where no other warning device is provided. These plugs are similar to those used in boilers, and may be placed in the discharge spaces of single-stage compressors, on the high-pressure side of 2-stage machines, or in the receivers, or other air containers or tanks. In case a dangerously high temperature develops, the fusible metal melts, and the opening so formed allows the air to escape with a shrill, whistling sound, thereby giving warning to the engineer. By varying the composition of the fusible metal in these plugs they are made suitable for use at different temperatures.

It is vitally important that periodical examinations be made of the entire installation, to insure its safe and satisfactory operation.—The Travelers Standard.

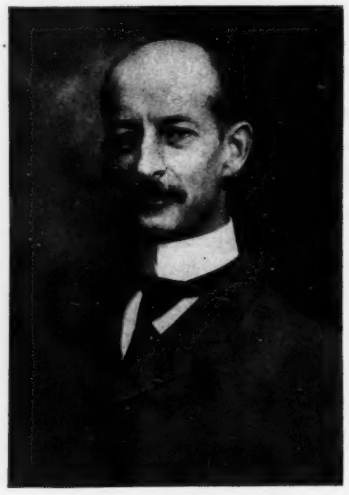
FROM THE United States Geological Survey bulletin, it is found that the coal output for 1915 has increased over that for 1914, although the conditions were adverse at the beginning of the year. The increase in production of bituminous has been about one per cent, the production in the eastern section having increased, while in the area west of Ohio there was a general decrease. This was due to the steady demand for export coal and coke in steel making, and the improvement in business in the eastern part of the country.

The decrease in the central and western sections was due to restricted use of coal by the railroads, more efficient methods of firing locomotives, and the fact that there has been competition of natural gas, petroleum and fuel oil, and from the development of hydro-electric power plants; also there was falling off in demand for fuel in the mines and smelters in Mexico.

President D. S. Jacobus

DAVID S. JACOBUS, recently elected president of the American Society of Mechanical Engineers, brings to the position working familiarity with the objects and needs of the Society which will be of the greatest advantage. He has been a member since 1889, has served on many important committees and held office as manager from 1900 to 1903 and as vice-president from 1903 to 1905.

Graduating from Stevens Institute of Technology in 1884, he became Associate Professor of Experimental Mechanics and Engineering, and in 1897 was promoted to a full professorship in the same subjects, in which capacity he served until 1906, being also in charge of the Carnegie Laboratory of Engineering from 1900 to 1906. He developed much original apparatus for illustrative and research work, and was largely engaged in commercial testing of steam machinery.



In 1906 the degree of Doctor of Engineering was conferred on him by Stevens Institute, with which he is still connected as trustee and special lecturer.

Since 1906 he has been advisory engineer, at the head of the engineering department of the Babcock & Wilcox Co., and has been responsible for much of the development in large water-tube boilers which has increased the range of capacity and economy of steam plants and brought about important changes in central station methods.

Dr. Jacobus has always been active in the steam field, and today ranks as one of its foremost authorities, many valuable papers from his pen being included in the transactions of engineering and scientific societies, of which he is a member, including Mechanical, Mining, Electrical, Naval and Refrigerating Engineers and the American Association for the Advancement of Science.

IN ONE PLANT where steam at 250 deg. F. is needed for industrial use, the engineer as told in Factory, avoided wasting exhaust steam and using live steam by passing the exhaust through a superheater in the breeching, thus raising it from 212 to 250 deg., and sending it to the industrial supply main.

Circulation in Horizontal Water Tube Boilers*

CONSIDERATION OF EFFECT HEADER DESIGN AND LOAD HAVE UPON CIRCULATION. BY PAUL A. BANCEL

WITH high combustion rates and high furnace temperatures, the load on boiler surfaces exposed directly to the fire is very intense. For a furnace temperature of 2500 deg. F. and a boiler temperature of 400 deg. F., the rate of radiation per square foot of boiler surface is about 100,000 B.t.u. per hr.; for 2750 deg. F., 150,000 B.t.u., and for 3000 deg. F., 200,000 B.t.u., corresponding approximately to loads of 100, 150 and 200 lb. of steam per sq. ft. respectively, whereas the load averaged for all the surface in a boiler is usually only 3.5 to 10 lb. per sq. ft.

It is important that the tubes subjected to these loads have ample circulation of water, and be kept clean of scale as well, otherwise the resistance to heat transfer on the water side of the tube will increase, causing an increase in the temperature of the metal, which if high enough, will result in rupture. An increase in tube temperature will also decrease the heat absorbed by radiation and reduce the efficiency. It is only in the region of these tubes that the velocity of circulation can have any appreciable effect on the efficiency of heat absorption.

In addition, it is generally believed that a high velocity of circulation will retard scale formation and thus indirectly reduce the resistance to heat transfer and prevent overheating of the tubes.

If there were no resistance the acceleration of a bubble of steam would be about 4000 ft. per sec. But the resistance reduces the velocity attained by the steam and at the same time imparts velocity to the water, so that the two velocities tend to approach each other, the more minutely subdivided the steam, the greater being the resistance to free rise through the water. In other words, the smaller the bubbles, the less the slip of steam through the water. When the subdivision is very great an emulsion is formed and we can assume that the steam and water flow together at the same velocity. The mixture is homogeneous and its specific gravity depends on the volumes mixed.

Experiments with the air lift indicate conditions which are favorable or unfavorable to slip. The quantity of water delivered rises to a maximum when the 2 fluids are equally mixed by volume, or the specific gravity is 0.5. The specific gravity falls off thereafter, due both to the increasing air volume and decreasing water volume.

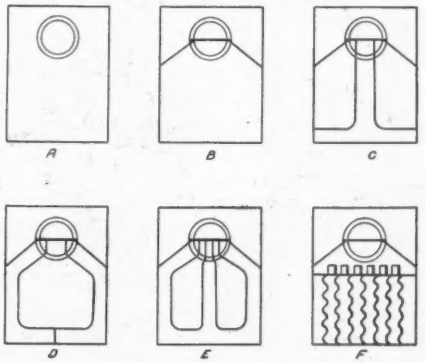


FIG. 1. DIFFERENT TYPES OF HEADERS TESTED

Slip is also influenced by the velocity, the ratio of air to water in the mixture remaining constant. The heat lost rises rapidly at low velocities but falls to a straight line at higher flows, whereas a friction head alone would rise approximately as the square of the flow. The loss in slip therefore decreases as velocity increases.

In 3 different types of water tube boilers the Babcock and Wilcox, the Heine and the Edge Moor, the steam volume formed in each tube decreases as we pass upward from the furnace and the specific gravity of the mixture discharged increases. This results in an increasing

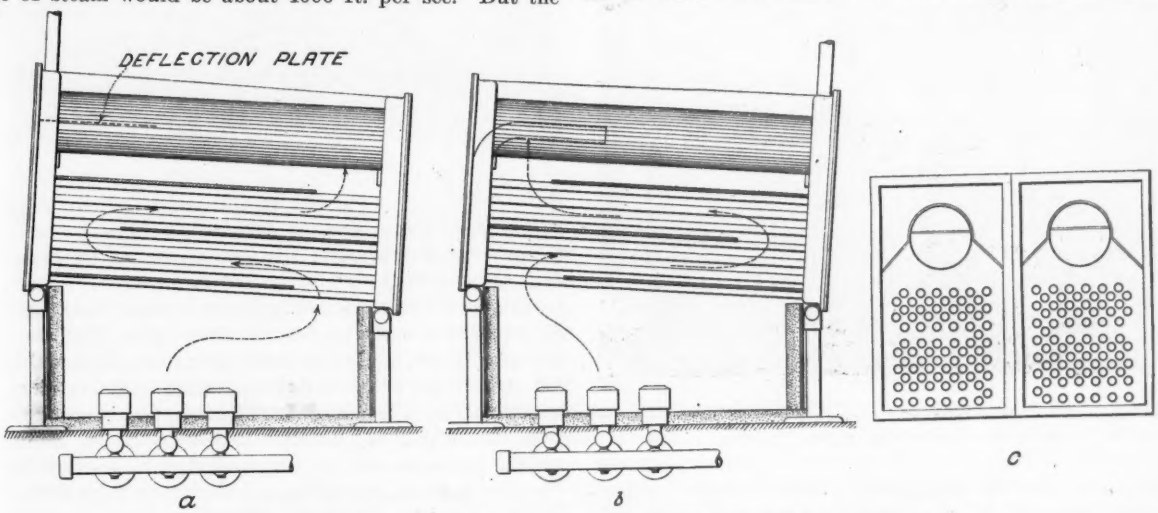


FIG. 2. MODEL WATER TUBE BOILER WITH DIFFERENT BAFFLE ARRANGEMENT

*Abstract of Paper Read before the A. S. M. E.

heaviness of mixture as we progress from the bottom to the top of the front waterleg and tends to choke circulation in the bottom tubes.

In the second place, the cross-sectional area of the front header being relatively large, an abrupt decrease in velocity occurs at the point of discharge of the bottom tubes, so that the steam tends to slip up without lifting

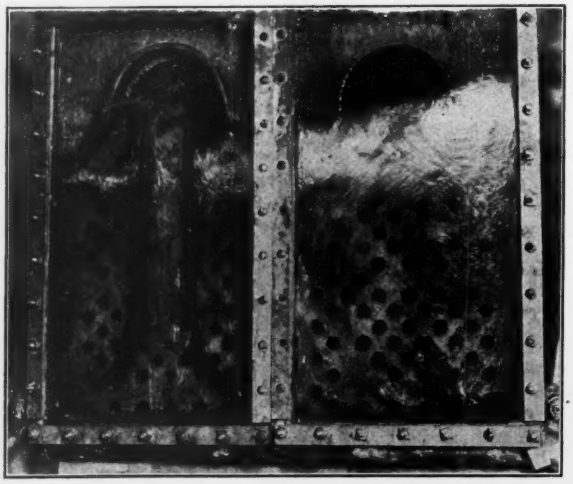


FIG. 3. FRONT HEADERS; LOAD 85 PER CENT; SETTING AS IN FIG 2 B

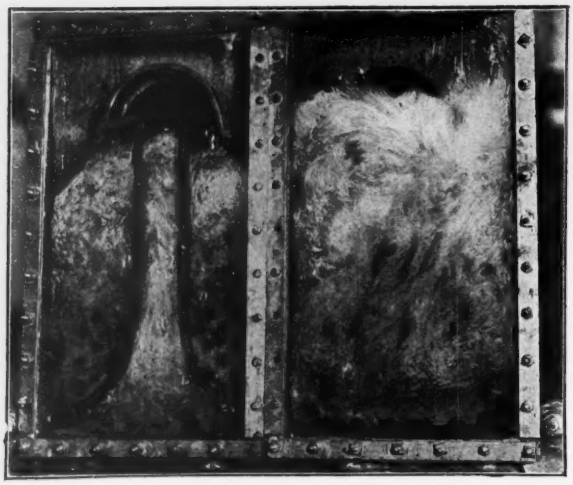


FIG. 4. FRONT HEADERS; LOAD 275 PER CENT; SETTING AS IN FIG. 2 B

the water. In the upper part of the header, the mixture comes from the tubes at relatively small velocity, and contains less steam, so that the conditions favorable to slip still exist. In fact, liberation of steam commences within the header, and the water tends to remain in place as in a large vessel—a tubular boiler, for example—instead of being pumped up into the drum. The head producing flow of water from the waterleg into the drum is created almost entirely by the tubes, and principally the bottom rows, whereas the rising steam bubbles in the waterleg should greatly assist the circulation in the tubes. Under these conditions, the higher the boiler the poorer may be the circulation; yet, in applying formulas of the kind given, it is assumed that the head producing velocity is measured by the height from center of tube to water level, and increases with the height of the boiler.

In waterlegs of the Heine and Edge Moor types there is also a loss due to the internal currents. The sectional construction of B. & W. boilers confines the flow to practically straight lines.

In all cases, there is a certain amount of resistance to circulation, principally that due to the sharp turn and constriction at the point of discharge of the front header into the drum, which is increased if a horizontal baffle or deflection plate, lying across the path of the steam and water, is used. A smooth large radius elbow is preferable. In the B. & W. type, the discharge occurs through nipples, and the reduction in area from the header to the nipple is considerable. In the Heine type, the discharge is through an opening in the drum of one half, one third, or less, of the flow area in the header. In the Edge Moor

FIG. 5. FRONT HEADERS; LOAD 275 PER CENT; SETTING AS IN FIG. 2 A

type, the header is carried up full width, but some head is lost since there must be sufficient hydraulic gradient to cause the flow from header into the drum which probably always acts as an open channel.

It seems that the velocity in the bottom tubes can be increased if the front header is designed so that the discharge of steam and water from those rows is isolated and led up into the drum in its own section of the header, as shown in Fig. 1*C*, *D* and *E*. The light steam-water mixture discharged by the bottom tubes does not impinge upon a denser mass of slow moving fluid in a large chamber but, instead, is segregated all the way up into the drum. The velocity of the mixture is maintained at its original figure so far as possible and abrupt changes in velocity are avoided, thus largely preventing the occurrence of slip. While only the same total inlet area to the drum is available, half or more is allowed for the discharge of the lower tubes and resistance due to constriction at this point avoided.

The circulation flues are carried up into the drum and should make a smooth large radius bend, preserving constant cross section. A horizontal extension of the flue in the drum, shown in dotted lines in Fig. 2, provides

separate liberating space for the large volume of steam formed in the bottom tubes, which under those circumstances does not have to boil up through superimposed water.

Model Boiler for Studying Circulation

In order to study circulation and the nature of the flow in different types of horizontal boilers, a model was constructed as shown in Fig. 2.

The boiler was built in 2 units, each complete with drum headers and tubes. There were 75 half-inch outside diameter No. 18 B. & S. brass tubes about 2 ft. long, of a total surface of 17 sq. ft. in each unit. The harders were rectangular as in an Edge Moor boiler, and by inserting suitable strips of brass the design could be changed to represent the different constructions of Figs. 1*A*-1*F*. Glass covers were placed on the front and back headers to permit observation of conditions and the taking of photographs. Rubber packing formed of split rubber tubing was placed on the edge of the strips under the glass.

A small group of bubbles moving at a velocity of 1 ft. per sec. would move 1/100 ft. during the exposure and make a streak 1/200 ft., or say 0.06 in., on the plate (8 by 10 in). Wherever bubbles of steam appear to be at rest in the photographs, therefore, it may be assumed that their velocity was no more than 1 ft. per sec., while streaks indicate higher velocities.

Steam was generated at atmospheric pressure and the volume was measured by orifices in the outlet pipes on each half of the boiler. As the volume of steam at atmospheric pressure is very great compared to that at 200 lb. (for example) a low load in pounds per square foot per hour on the model corresponds to a high load in terms of steam volume. The equivalent loads given in connection with the pictures are based on a boiler pressure of 200 lb., at which the steam volume is about 0.08 that at atmospheric pressure.

A greater proportion of the steam was generated in the bottom tubes. The relative loads in different rows was probably about the same as the average in an actual boiler, wherein the distribution varies considerably depending on the furnace temperature.

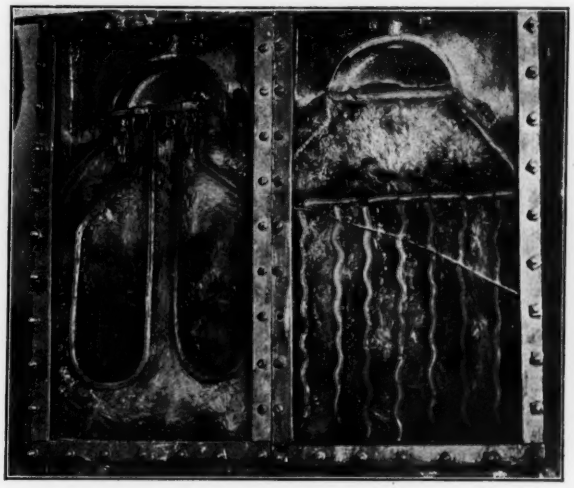


Fig. 6. Front headers; load 450 per cent; setting as in Fig 2 A

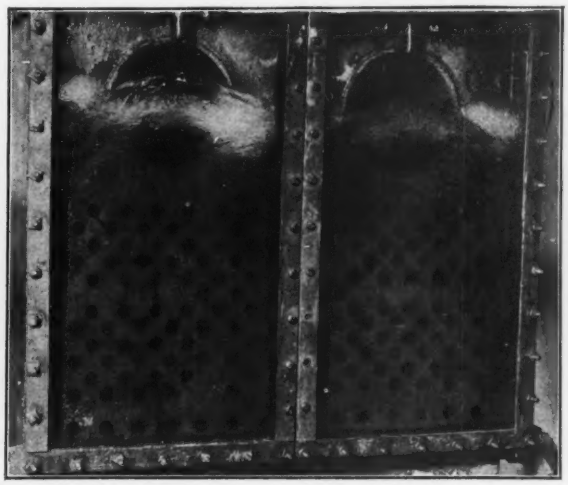


Fig. 7. Rear headers; corresponding to design of Fig. 3 in front; load 450 per cent; setting as in Fig. 2 B

The boiler was set with a slope of 1 in. to the foot over a gas furnace consisting of 3 large burners capable of burning 200 cu. ft. of gas an hour. One-inch asbestos lined the furnace and boiler casing. The baffling for the gases was of the parallel type in 2 passes. The boiler was set so that the gases entered at the rear of the bottom pass, Fig. 2*a*, and also with the relative position of furnace reversed, the gas entering the first pass directly in front, as shown in section of Fig. 2*b*. An induced draft fan drew the gases through the boiler.

Photographs of the Boiler Circulation

Photographs of the moving steam and water in the headers were taken at a speed of approximately 1/100 sec. with flashlight illumination.

When the circulation is poor and steam is slipping through the water, the latter shows up transparent and the header appears almost empty. Whereas where the steam and water are well mixed or emulsified, there is, in the photographs, a distinct whitish color and marked contrast in the photographs.

Figure 3 shows the circulation in the front headers at about 85 per cent of rating. On the left is a header with a flue for increasing circulation in the bottom tubes, and on the right the square header.

In the left-hand half of Fig. 3, the greater evaporation is obviously taking place in the bottom tubes connected into the circulation flue where there is a well directed upward flow. The upper tubes of the boiler discharge into their compartments of the header very quietly and the steam slips up through the water and is liberated in the header. The pumping action, as in an air lift, is shown clearly in the central flue. The discharge is vigorous enough to strike the horizontal deflection plate in the center of the drum.

The right-hand half of Fig. 3 illustrates how slip occurs in a header of relatively large area; the steam slips up through the water and is liberated largely in the header as indicated by the wide belt of foam formed at the surface of the water, which is to be contrasted

with the quiescent conditions on the left. The steam and water issued from the bottom tubes as a homogeneous mixture filling the bore of the tubes and preserved this state as it turned up, but after a short distance it seemed to be absorbed by the comparatively large mass of water in the header. The tubes carrying lighter loads discharge steam and water from the upper part of the tube only.

A rotary flow can be seen in the square header, Fig. 3. The current rises at the left and falls at the right, the velocity being low or next to nothing where the bubbles can be distinguished.

Figure 4 shows the boiler steaming at approximately 275 per cent load. The upper tubes of the left-hand boiler are now working more actively, but the relatively small amount of steam generated is indicated by the fact that about half the rows of tubes can be seen through water, the steam slipping through without causing a flow of water. The flow in the circulation flue is smooth and full bore. On the right there is violent commotion with whirls and swirls in all directions. The steam and

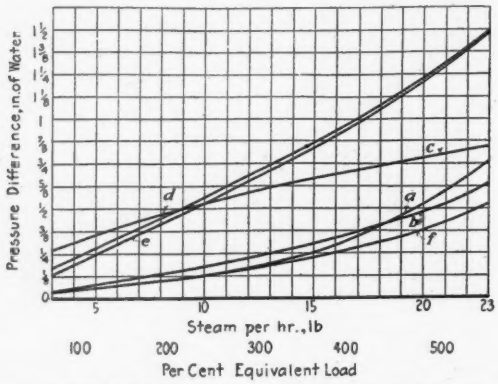


FIG. 8. PRESSURE DIFFERENCE BETWEEN FRONT AND BACK HEADERS WITH VARIOUS LOADS AND TYPES OF HEADERS

water rise nearly to the top of the drum which indicates the head needed to make the turn and discharge the mixture into the drum.

Figure 5 shows Heine type headers in both parts of the boiler and double circulation flues on the left, these rising along the sides of the header in extensions which did not connect with any upper boiler tubes. No heavy mixtures were therefore discharged into the light steam water emulsion rising from the bottom tubes. The load was about 275 per cent. The discharge of the upper tubes of the left-hand boiler slips through the water and the mixture in the center, near the top, is moving slowly, whirling in all directions. The right-hand picture illustrates again the tendency for internal circulation in an open header; there is a marked rotary flow and downward current on the right. A closer study of the figure will show what seem to be light shadows to the left of the tube ends in the bottom row. This is the discharge of steam slipping through the water.

Figure 6 shows a third arrangement of circulation baffle with 3 flues on the left, and a B. & W. type header on the right; the load was about 450 per cent. The flow in the sections of the header was directly upwards, with no cross currents or whirls, and only a slight sinuous movement, but was throttled by the nipples (not visible in the cut) at the top of each section. Stationary bubbles can be distinguished in many of the headers. At low loads the slip through the headers was similar to that in the previous types, the bubbles rising through the water without causing discharge from the nipples.

Figure 7 shows the rear headers when the boiler was set, as shown in Fig. 2*b*, and the load was about 450 per cent. The rear headers were perfectly clear, and no discharge occurred from any of the tubes. The front headers were of the design shown in Fig. 3, which figure was also taken with the flow of hot gases entering the tube nest at the front.

Pressure Difference Tests

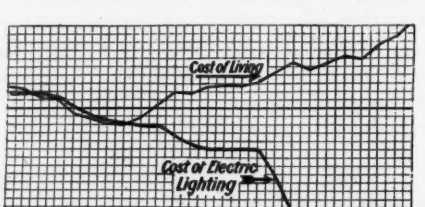
Tests were made in which the difference in pressure between the bottoms of the front and rear headers was measured. The boilers were set with the hot gases entering at the front. A mercury U tube with legs at a small angle from the horizontal was used for these readings, which were then translated into equivalent inches of water.

In Fig. 8, curve *a* shows the pressure difference, at increasing loads, for the plain square header of the Edge Moor design, Fig. 1*A*. Curve *b* shows the same relation for the Heine type, Fig. 1*B*.

Curve *f* shows the pressure difference with the B. & W. type header, Fig. 1*F*. Curves *c*, *d* and *e* show readings when circulation flues, as shown in Fig. 1*C*, *D* and *E*, were used in the front header. The curves for headers, Fig. 1*D* and *F*, practically coincide. Figure 1*C* gives lower values at the higher loads and slightly higher at the low loads. This is probably due to the fact that with Fig. 1*C* the discharge from the bottom tubes is mixed with the discharge from a considerable number of upper tubes in the boiler, which also discharge into the central part of the front header.

The circulation flues increase the pressure difference front and rear of the bottom tubes and add to the circulation created in the tube itself, due to its slope. The effect of the nipples of the B. & W. construction in throttling circulation as compared to the plain header construction is not noticeable until about 300 per cent load is reached.

This interesting chart shows the lowering cost of electric lighting, in contrast with the rising cost of living. True, the chart applies to the cost of electric light only, in which the reduction has been greatest, mainly on ac-



count of the improvements in the Mazda lamp, but the cost of the current itself has also been reduced, as a result of the rapidly increasing use of electricity for other purposes, in the home and in the industries.

LETTERS DIRECT FROM THE PLANT

Cash Paid For Ideas Accepted. Sketches Desirable.
We Make The Drawings

Installing a Gasket

ONE OF the innumerable unpleasant jobs so often met with by members of the engineering fraternity is the installation of gaskets in pipe-lines. Too often the difficulties are increased by a lack of knowledge only gained by experience of the best methods of handling this work.

Let us consider a joint in which the gasket has blown out. We will suppose that this gasket must be replaced during the noon hour, therefore it is essential that we have everything prepared before the plant shuts down at noon.

By dropping a line over the flange as shown in Fig. 1, and measuring across the 2 drop lines, we can ascertain the outside diameter of the flange. Set divider's points to half this diameter, and draw on a sheet of packing a circle, which gives the outside measurement of our gasket. Measure distance from the outside of the flange to the center of bolts, and if all bolts are at equal distance, reduce divider points that amount, and draw the bolt circle. If it is found that all the bolts are not at equal distance from the edge of the flange, draw the bolt circle, and lay out the bolt holes, marking each hole on the gasket and also marking the flange so that holes will correspond when the gasket is put in place. Measure with divider points from center of bolt to center of bolt, and mark on gasket, and cut out full size of hole. Reduce divider points to half the inside diameter of pipe, and mark out pipe circle. Cut gasket out along the outer circle, leaving the corner piece, as shown in (B), Fig. 2, which, by the way, shows the general layout of a gasket after being cut out.

Cut out the pipe circle, and also 2 V notches as in x, Fig. 2. Corner piece B, Fig. 2, affords a ready means to guide the gasket to its proper positions. The gasket is now ready to install. Have ready a hammer, chisel, pinch-bar, at least one extra flange bolt, with nut and washer, and 2 pieces of iron about 1 in. wide and ¼ in. thick shaped in the V form as shown in Fig. 3. First be sure that the gas or liquid that the pipe carries is shut off, and where it is possible it is advisable to open a drip to look after the leakage past the valves.

Never touch a bolt in the flange of a high-pressure steam line joint until you are absolutely sure that there is no pressure in the pipe. In loosening flange bolts, the following method should be employed. In Fig. 2, it will be noted that the bolts are numbered; it is good practice to loosen the bolts in the same way that these bolts are numbered, preventing an undue strain being thrown on one side of the flange, which strain might be very great if the 2 sections of pipe are not in line. In loosening the last 2 bolts, both should be set back a little at a time, so that if the joint should suddenly open, the strain will not come all on one bolt.

If the joint does not spring apart (and if the piping is properly installed, it seldom will spring open) after the last 2 bolts are let out about ¼ in., it will be necessary to open the joint with a chisel and a hammer. In doing this, the chisel point should be moved around the joint until the joint opens.

Hold the joint open with the pinch bar, and insert the 2 V irons, one on each side of the flange in the manner shown in Fig. 4. Then clean out the old gasket; a thin flat file makes a good scraper to do this work. It is very important that all the old gasket is removed, as an improperly cleaned flange will generally result in the blowing out of the new gasket.

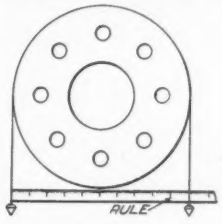


FIG. 1

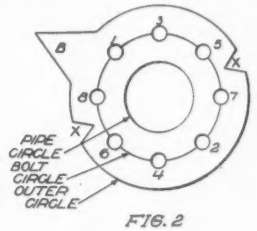


FIG. 2

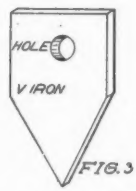


FIG. 3

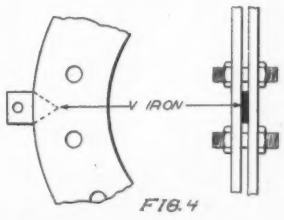


FIG. 4

FIG. 1. MEASURING DIAMETER OF GASKET
FIG. 2. GASKET LAID OUT FOR CUTTING
FIG. 3. WEDGE USED TO OPEN JOINT
FIG. 4. METHOD OF USING WEDGE

Give the new gasket a coating of graphite and oil on both sides, and then insert between the flange plates. Care must be taken not to tear out the bolt-holes, and to fit the V notches in the gasket into the V iron points.

Put all bolts in place and set up finger tight, then remove V irons. (A point of a pin or large nail in the hole in V iron makes a simple means of withdrawing.)

Set up with wrench all bolts as taken out. That is, set up one bolt on one side of flange, then set up the corresponding bolt on the other side of the flange: by doing this the strain will be equalized as the joint is made up. The gasket is now installed.

With the common sheet rubber packing, it will be necessary to follow up on the joint from time to time for the first few days that the gasket is in service.

There are a great many sheet packings on the market at the present time that require very little following up.

A. D. PALMER.

Foot Pounds and Pound Feet

A COMMON error for even the best engineers, is to use the expression "foot pounds" when "pound feet" should be used.

The difference is clearly shown in the accompanying sketches.

IN FIG. 1, showing the internal connections of a single-rope, being raised by a windlass. It has been lifted a distance of 2 ft. $2 \times 100 = 200$. Therefore, 200 ft. lb. of work has been done.

In Fig. 2, I show a weight of 100 lb. on the end of a cantilever beam, distant 2 ft. from the wall. It is

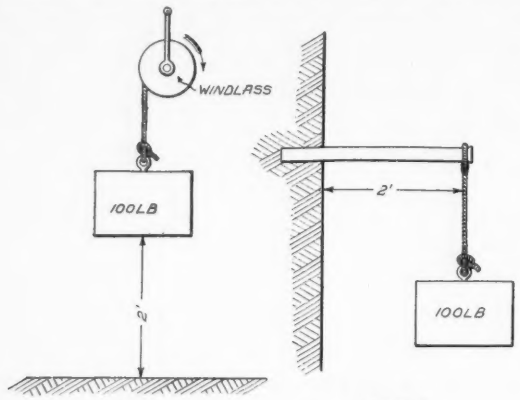


FIG. 1 FIG. 2

FIG. 1. DIAGRAM REPRESENTING 200 FT. LB. OF WORK
FIG. 2. REPRESENTATION OF 200 LB. FT. BENDING MOMENT

at the wall where the bending moment, or tendency to break, is greatest, and it is obtained by multiplying the weight by the lever arm. $2 \times 100 = 200$. The weight here does not do work, and the beam does not do work. We therefore must call the bending moment 200 lb. ft.

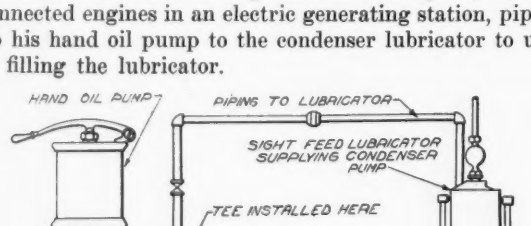
In other words, "foot pounds" should be used only as an expression of work. "Pound feet" have nothing to do with work.

In the same way, if inches are used instead of feet, Fig. 1 represents a potential energy of 2400 in. lb. and Fig. 2 represents a bending moment of 2400 lb. in.

N. G. NEAR.

Filling Lubricator

THE ENGINEER in charge of some low-speed, direct-connected engines in an electric generating station, piped up his hand oil pump to the condenser lubricator to use in filling the lubricator.



OIL PUMP PIPING FOR FILLING LUBRICATOR

A tee was installed between the pump and the valve in the pipe leading to the engine cylinder. A pipe line led from this tee to the lubricator filling plug; a valve was inserted in this line also. When it is desired to fill the lubricator, the valve in the line leading to the cylinder is closed and that in the lubricator line opened and the oil pumped from the hand pump into the lubricator, the water in the lubricator being forced back into the steam line.

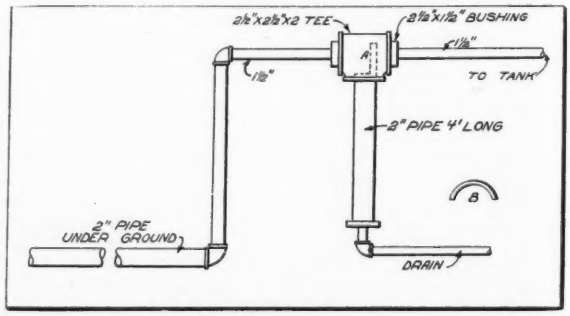
This would be an objectionable feature if the lubricator supplied any high-speed apparatus, but is not so bad in a line supplying a condenser pump.

The advantages are: Not necessary to drain lubricator; no time wasted and no muss around engine; oil always warm, as oil pump is near high-pressure cylinder and always warm; the feed of the lubricator is never disturbed; no oil wasted, as the oil pump has a glass bowl and can be filled nicely. In the case that came to my notice, 3 ft. of ¼-in. brass tubing, 1 union and 1 valve were used besides the tee. E. E. KAICY.

Air Separator

OUR AIR PIPE leading from the receiver tank to where the air is used, is partly under ground, as shown in the illustration and is not covered. During the fall and spring we used to be troubled with much water in the air, which I believe was due to the pipes being in the ground and not covered.

Much air was wasted in trying to blow the water out of the pipe.



SEPARATOR FOR AIR LINE

To overcome this trouble, I made an air separator, as shown in the illustration. The pipe leading from the air receiver tank to where the pipe comes out of the ground is 2 in., then reduced to 1½ in. close to where it comes out of the ground, and where the 1½-in. pipe runs horizontal. A 2½ by 2½ by 2-in. cast-iron tee is used, reduced to 1½ in. on each end by bushings. Into the 2-in. opening of the tee a 2-in. pipe 42 in. long is screwed with a long thread, where half of the pipe is sawed away to form a half circle, as shown at B. This half circle reaches within ½ in. of the top of the tee, as shown at A, while the other end of the 2-in. pipe is closed with a cap tapped for a ½-in. pipe used as a drain.

The apparatus operates in the following way: Should any water be in the air line it will strike the half circle of the 2-in. pipe in the tee, then drain into the 2-in. pipe from where it is drained out by opening a cock.

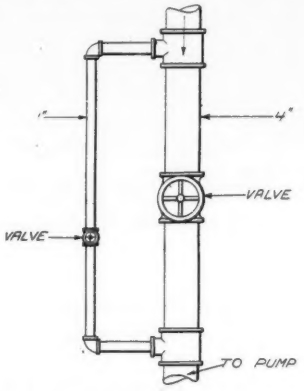
Since this separator has been in use, there has been very little trouble with water in the air, and it is my intention to place a trap so as to drain the 2-in. pipe automatically, as now the drain cock has to be opened by some employe who forgets this at times.

H. A. JAHNKE.

Bypass Valve for Feed Pump

DURING THE recent business depression, the load on our plant and consequently the demand for steam decreased to such an extent that only an extremely light load was carried on the boilers.

As a result, the feed pump which was installed to take care of full load normally was running only at very low speed; and because of excessive drop in pressure, wire-drawing and erosion of the valve seats, trouble was experienced when throttling down the valve on the steam supply line to meet the very light requirements.



BYPASS AROUND MAIN STEAM VALVE TO PEED PUMP

We therefore installed a small 1-in. pipe bypass around the valve in the 4-in. main steam line, as shown in the sketch.

This small bypass pipe was of sufficient capacity to pass approximately the amount of steam required to run the pump; and by closing the large valve completely, the use of the small valve in the bypass line enabled us to secure excellent control. Of course, when the load increases to such an extent that the 1-in. pipe will not pass sufficient steam, we revert to the use of the main line. M. SALLER.

Burning Lignite

HAVING READ the articles on the burning of lignite in the issue of Nov. 15, and also of Dec. 15, I wish to state that I have installed in the state of Texas about 50 plants where they are burning lignite with the McClave forced draft system. These are showing fine results, and are carrying some of the boilers over 50 per cent above their rating.

For boilers of 125 hp. we recommend furnaces 5 ft. long by 6 ft. wide, and for 150 hp. we make the furnaces 6 by 6. Our installation consists of the 2 McClave grates, high duty Argand steam blowers, automatically controlled. We cut down the bridge wall, allowing 18 in. from top of grates to shell of boilers, and when we do not find sufficient space from top of grates to shell of boiler, we use a drop dead plate, which lowers the grates 4 in.

There is a blower which forces air into the ash pit of each boiler, the only air reaching the furnaces has to come through the blowers, which are automatically controlled by regulator. I find that lignite can be burned more successfully with the dutch oven.

CHAS. GRUNEBERG.

Safety Device for Valves

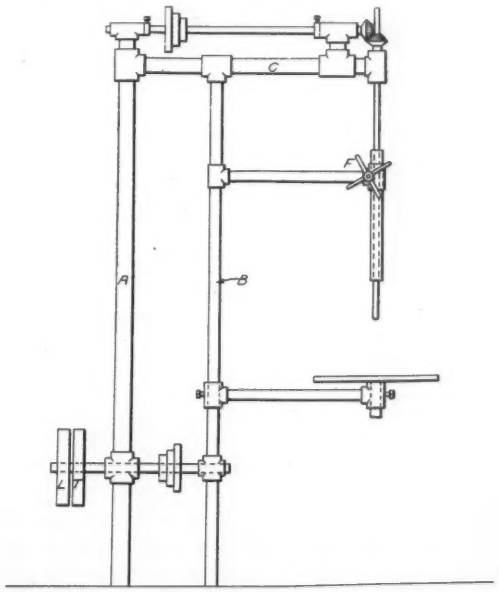
IN THE accompanying photograph is shown a safety device for locking on stop valves, blowoff valves, etc. It is not original with me, but I have used it consider-

COVERING TO LOCK OVER VALVE HANDLE

ably and think it is O. K. It can be made of tin or wood with tin tacked around the circumference. Don't forget the lock with key. WILLIAM E. DIXON.

Homemade Drill Press

IN A little shop, in a small town, I recently saw a homemade drill press which answered the purpose excellently. Constructed of pipe and pipe fittings, the columns A and B embedded in concrete, shafts of cold rolled steel in babbited bearings, the table at liberty to move up and down, locked by means of set screws. The



DRILL PRESS MADE LARGELY OF PIPE AND FITTINGS

drill was fed by handle F, on the end of a small shaft carrying a gear, meshing in a rack on spindle sleeve. Tight and loose pulleys were placed on lower shaft and cone pulleys on shafts giving 3 changes of feed.

A small press of this kind would be very useful around an engine room. It could be built very cheaply, and in spare moments. TOM JONES.

Successful Kinks From The Plant

For Saving Time, Work and Trouble

Pump Repair

SOME TIME ago, a duplex steam boiler feed pump was broken, as shown at *a* in Fig. 1. This was caused by the person who fitted up the pump at the factory when the pump was built; the studs that were fitted into the pump casting to hold the pump cover down were too short, this particular stud being screwed only about 4 threads into the casting. When the pump repair man

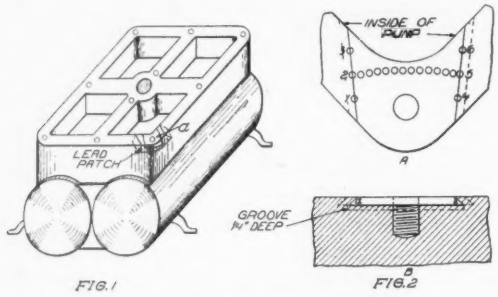


FIG. 1. BREAK IN DUPLEX PUMP
FIG. 2. METHOD OF REPAIRING CASTING

was bolting cover down after putting in a new set of valves, he pulled too hard on this stud for the hold it had in the casting and consequently a piece of the casting was broken out.

This was successfully repaired as shown in Fig. 2.

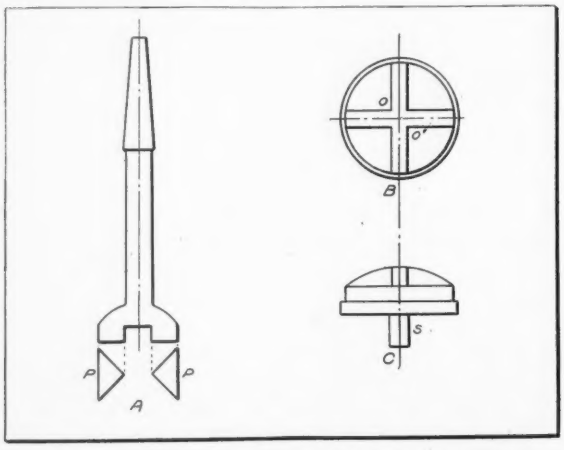


FIG. 1. TOOL FOR REGRINDING PUMP VALVES

Six ¼-in. holes were drilled at equal distances across the face of the joint and were drilled in on a slant, as shown in Fig. 2B. Then a row of holes were drilled from hole No. 2 to hole No. 5 along the inside of the stud hole. This row of holes was chipped out to form a groove, about ¼ in. deep. A hack saw was now used and a bevel cut run down to the level of the bottom of broken part, as shown at *a* and *b*, Fig. 2B. The metal inside of these saw cuts was all chipped out so as to leave a space into which lead was poured, after the stud was screwed into place.

The lead was now hammered down tight, so as to fill the groove and holes completely, after which the surface was dressed down level, with a file. The hole for the stud was drilled out deeper and tapped, and a longer stud made and fitted in place.

This repair has been in service for several months, has never leaked and has stood a pressure of 240 lb. per sq. in. gage. HARRY W. BENTON.

Two Handy Homemade Tools

RECENTLY, I was requested by the owner of a small plant to grind in the brass water valves of a receiver pump. When I looked the job over, I found that no suitable tools had been provided with which to do the work. A handy tool for the purpose was made of an old discarded wood bit, as shown at A in Fig. 1. The bit was cut off and flattened close to the shank, and the projections P and P′ shaped so that they fit nicely in the corners O and O′.

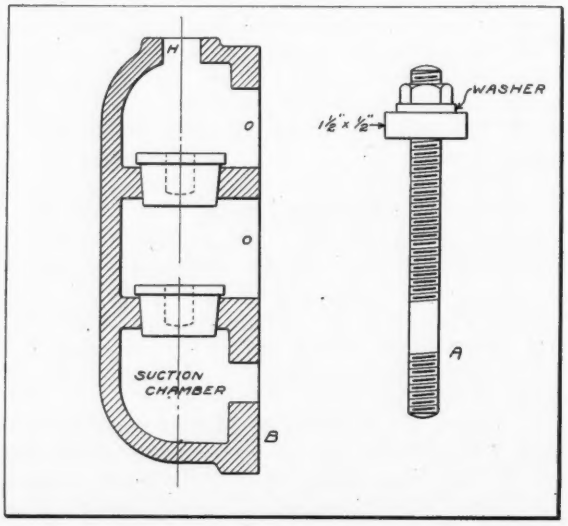


FIG. 2. BOLT FOR REMOVING VALVE SEATS FROM PUMPS

The stem of the valves S served to hold them in position while the work was being done. With a little abrasive mixture placed on the valve seats, a few turns of the tool, which was held in a carpenter's bit stock, soon completed the work of grinding in the valves.

A short time after, and in the same plant, I had to remove some valve seats from a vertical single-acting triplex water pump. In this case, also, there was no suitable tool at hand for doing the work.

Figure 2 illustrates the method by which the work of removing the valve seats was accomplished. It will be seen that the bolt is threaded at both ends, the same as with the usual stud bolt. The longer thread on the upper end is necessary in order that one bolt may be used to remove either a suction or discharge valve seat. The strip of 1½ by ½-in. flat iron was placed over the hole H, from which the plug is removed. The washer presents a smooth surface for the nut to turn on.

When the nut bears on the washer, a turn or two, with a monkey wrench will usually loosen the seat, when it can be drawn through the opening at O. Both tools, with which these jobs were done, were made of material selected from the scrap lying about the plant, and are just as serviceable as any others. These are now kept in a convenient place for future use.

KARL HOFFMAN.

Improvement in Water Pistons

OUR OLD water pistons were the common soft packed type, as in Fig. 1, and they required lots of care to keep them in tight condition, and lasted only about 2 months before requiring repacking, besides wearing shoulders and bellying out the center of the cylinder as indicated at A, B and C in Fig. 1. This caused short strokes when the new packing would stick at the shoulders and this poor condition of cylinder required greater piston speed to keep up the demand. Split metal rings of neat fit did no better, so we improved conditions as follows:

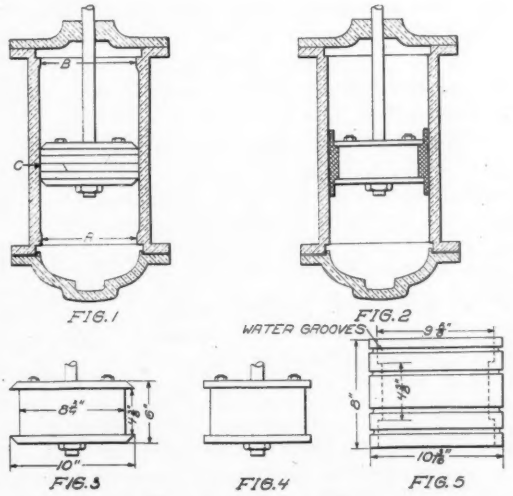


FIG. 1. SOFT PACKED WATER PISTON
FIG. 2. NEW PISTON AND PACKING IN PLACE
FIG. 3. DIMENSIONS OF OLD PISTON
FIG. 4. NEW PISTON
FIG. 5. WHITE METAL BUSHING PACKING

The old piston, F, Fig. 3, was re-turned to the shape of Fig. 4, and a white metal bushing packing made, with dimensions as in Fig. 5, to fit the pumps after they were rebored. This increased the length of the piston, allowing the piston to travel over each end of the cylinder bore, preventing the forming of shoulders and giving at all times a full stroke and even wear of the cylinders. These pistons have been in steady use for 18 months, and are in excellent condition at present, showing hardly any wear, also handling water of 210 deg. and higher, that is delivered to the pump suction at 20 lb. pressure. This is cheap pump packing for, when worn out, it can be used to melt with a few pounds of new metal and a new bushing cast and turned to fit.

Water grooves may be turned in it as shown, to prevent any leakage past the piston, the water catching in the grooves and forming a seal. C. H. WILLEY.

Facing Device for Brass Pump Valve Seats

SOME TIME ago it was brought to the writer's attention that much waste of material and labor was occurring in connection with the repair of brass water valve seats in water pumps passing through the shop for repair and general overhauling. The seats were being removed from the water end or body of the pump by means of a fork wrench dropping down through the bridges of the brass seat. If the valve moved in spite of the corrosion and rust cementing it in, without much damage to the seat, it was faced in the lathe and returned to the pump; however, in many cases, the valve bridges were torn out in an attempt to loosen the valve with the wrench.

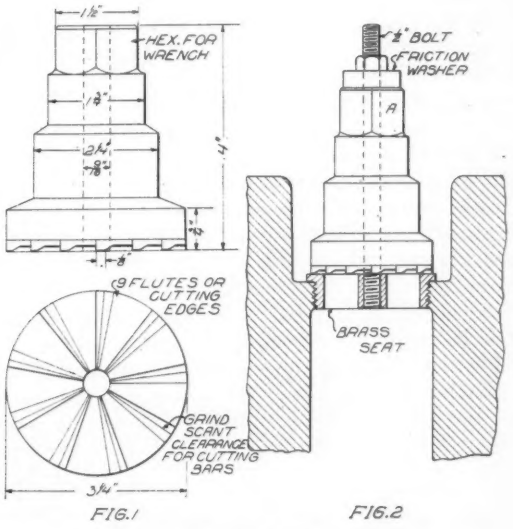


FIG. 1. REAMER FOR VALVE SEATS
FIG. 2. APPLICATION OF REAMER

Figure 1 is descriptive of a flat face reamer made of tool steel for the 3-in. valve seats, and Fig. 2 will show the exact manner of its application and use. By giving the cutting edges but little clearance, the temporary bolt or guide, A, screwed into the spring post seat will hold the reamer to the valve seat with little effort, and at the same time result in a smooth flat face cut by the edges of the reamer.

The device can be used to advantage on almost any kind of pump, as it can be turned with a socket wrench, when the arrangement of the body of the pump makes it inaccessible with any other. The little arrangement will soon pay for itself in undamaged valve seats and expense of labor in connection with the repair and upkeep expenses. F. W. BENTLEY, JR.

Questions Answered and For Answer

Expert Help When In Trouble. If You Want Quick Answer Enclose a Stamp

Use of B Valves in Knowles Pumps

WHY, IN THE Knowles pump, is a B slide valve used instead of a D valve?

2. Why are the heads of return-tubular boilers generally placed so that the flanges of one point outward and the other inward? A. B. R.

ANSWERS

THE B VALVE is used in order to reverse the motion of the piston. In the B valve, steam is admitted under the inside edge of the valve, hence the direction of motion to admit steam is the reverse of what it would be with the D type. It is a matter, in this type of pump, of choice of the designer, since a valve motion can easily be provided which uses the D-type valve.

2. So far as the 2 heads of the boiler are concerned, it is a matter of convenience of manufacture. Both heads might be put in with the flange pointing out, but this would reduce the length of the tubes. With both flanges pointed in the same direction, one head is put in and riveted—a man working inside the boiler to hold on the anvil while the riveting is being done. If the other head were put in the same way, it would be very inconvenient in riveting, and in case it became necessary to take out one head, it would be an almost impossible job.

Another thing that comes in, by turning the back head with the flange in, the joint and rivets are protected from the heat by the water inside, while the rivets and joint at the front head are in the dry plate space, where the gases are comparatively cool, having passed through the tubes and given up their heat to the steam. A. L. R.

Turbine Operation Difficulty

WHAT CAUSES the governor of a 75-kw. Curtis turbine to stick and fail to admit steam when first being started?

We are compelled to lift a lever before the turbine will take steam. After starting, however, it works satisfactorily. R. L. L.

A. We should judge this to be a 75-kw. Curtis steam turbine with mechanical operated valve gear which consists of a number of separate valves which are opened and closed by dogs fastened to a reciprocating lever rod. The dogs have a continuous reciprocating motion and whether or not they operate the valve depends upon the position of a series of shield plates which is operated by the governor. When a valve is once opened and turbine is in operation, pressure of steam in the bottom of valve keeps it open.

In addition to the above, the packing around the valve steam should be tight enough to prevent the valve, which is very light, from seating. When the throttle valve is closed, and the machine comes to rest, the governor causes all valves to be opened and they should remain in this position, due to the friction of the packing on the valve stems. It sometimes happens that packing is worn and does not hug the valve stems tight enough to keep them up.

We believe if you will screw down on the stuffing-box controlling the valve stem packing, that the difficulty will be eliminated. GENERAL ELECTRIC CO.
G. R. KNIGHT.

Steam Turbine Questions Asked by Massachusetts Examiners*

HOW DOES steam in a reaction type, low-pressure turbine discharge?

A. In a plane at right angles to the shaft.

57. How much will the low-pressure turbine save on a noncondensing engine?

A. It will double the peak load without any more cost for fuel.

58. As the steam supply from the engine is not continuous, how do you get a continuous flow of steam in the turbine?

A. We use a steam regenerator that stores the heat of the engine exhaust steam in water which evaporates into steam for the turbine, as it is required; the effect is similar to that of a flywheel storing energy.

59. How is the low-pressure turbine governed (Curtis)?

A. By varying the pressure instead of governing by nozzles; they may have hand operated valves in first stage which accomplishes the same results as to light loads and economy as does the governor on a high-pressure turbine.

60. What is the mixed-pressure turbine?

A. A low-pressure turbine can be made with a section fitted with special expanding nozzles to receive live steam from the boiler; this is better than using a reducing valve. This extra supply is governed by regular governor.

61. What will prevent a turbine from running away with no load?

A. There is a safety stop mechanism. This governor trips a bottom fly valve closed by a weight. When running, the valve is held open by a latch; when the turbine runs above normal speed, the speed governor works and trips the latch and the valve closes.

62. Why can you safely start an impulse turbine quicker than a reaction type?

*Continued from page 1103, Dec 1 issue.

A. The clearance is so large in the impulse type that the throttle may be opened as fast as you can open it.

63. Why don't you get more initial condensation than you do?

A. As the steam passes the same way continuously and the temperature at any point in its path remains constant, there is little condensation loss.

64. What is the step supporting screw?

A. A large screw comes up through a circular block of cast iron (cover plate) and it supports the lower half of the step bearing. W. N. L.

(To be continued.)

Underground Air Conduits

I WOULD LIKE to obtain some information regarding the proper method of building underground air conduits; that is, whether they should be built of concrete, brick, or other material. I would like detailed information as to the best method of constructing the bottoms, sides and tops or roof of conduits. G. S. C.

A. In regard to the construction of underground ducts for air, this depends largely on the size of the duct. For small ducts, glazed sewer tile is frequently used, laid on a bed of gravel with an under drain pipe, and with the joints of the main line of bell form, calked with lead and oakum. For larger conduits, either brick or concrete construction may be used.

For the brick, the usual construction is a concrete bottom, made of a mixture of 1-2-5, of cement, gravel and broken stone, the concrete being laid 4 in. thick on a bed of cinders 6 in. thick. On top of this, side walls 8 in. thick are erected; the top is covered either with a brick arch or with a slab of concrete reinforced with expanded metal. If a brick top is desired, and it must be flat, it may be made of brick laid on T iron.

For concrete, the same kind of a bottom is used. The walls are made 4 in. or 6 in. thick, according to the size of the conduit, and the top is made arched, of solid concrete, built up on a form, or flat of a reinforced concrete slab. In either case, the inside of the conduit should be faced with cement mortar, made in proportions one part sand and one part cement, in order to give a smooth surface. The size of the conduit is usually made such as to give a velocity of 2000 ft. a minute for the air.

If the conduit is of considerable length, it usually pays to line it with an insulation material, such as pressed cork board or asbestos block, fastened securely to the walls, and the inside of this lining finished with the cement mortar. A. L. R.

Advantages of 4-Valve Engines

WHERE IS the dry plate of a boiler?

2. Give 5 advantages of 4-valve engines over those of the ordinary slide-valve type. J. D.

ANSWERS

IN THE flush front horizontal return-tubular boiler, the smoke box at the front end of the boiler is over the fire doors, and the part of the sheet which extends beyond the front head is called the "dry sheet." This is not protected by water on the upper side, but has a firebrick lining on the underside to keep the heat of the furnace away from it.

2. Some advantages of a 4-valve engine over a common slide-valve engine are: (a) Steam clearance is much lower than is possible with a single-valve engine. (b) The valves may all be operated by one eccentric, or the steam valves may be operated by one eccentric for them exclusively and the exhaust valves by another one, either of which can be adjusted without interfering with the other. (c) The valve ports may be made short and direct. (d) Quick cutoff and variable cutoff. (e) Steady admission pressure. G. A. T.

Repair Costs

WHAT IS a fair percentage, based on the original cost, for repairs in a plant running on its fourth year, and consisting of water-tube boilers, alternating current generating sets, refrigerating machinery, and a hot-water heating system? Plant operates 24 hr. a day. I. O. M.

A. It is almost impossible to determine what percentage of the original cost of a plant the expense for repairs will be for any given piece of apparatus or for any year. This is an extremely variable figure, and depends entirely upon the load, the care with which the machinery has been maintained, and the age of the machine or machines.

It will be found that the expense for repairs will increase with the age of a machine, that is, towards the end of the useful life of any machine, the repairs will become such an amount as to warrant the purchase of a new one.

Kent gives an average figure of about 2 or 3 per cent for repairs per year, based upon the original cost of the equipment. This figure covers the entire equipment, including boilers, engines, turbines, electrical equipment, etc. Gebhardt, in his book on "Steam Power Plant Engineering," recommends 2 per cent as a fair figure for this item. O. H. H.

Proper Vacuum

WHY IS IT that vacuums greater than 26 in. give practically no added economy to reciprocating engines? I have always been under the impression that the greater the vacuum, the greater the economy, but it seems there is a difference of opinion on the subject. R. C. H.

A. There is an added heat economy in the steam engine cylinder from increase of vacuum to greater than 26 in.; but the difficulty, from a practical standpoint, is that the size of cylinder required on the engine to take care of this increased volume of steam, due to the greater vacuum, and the increased capacity of the vacuum pump, as well as the greater volume of cooling water required, make it commercially uneconomical to attempt a greater vacuum than 26 in. with a reciprocating engine. Because of the reciprocating motion, we are limited in the speed at which the engine may be run.

The only way we can take advantage of the greater vacuum is by increasing the cylinder size. In the turbine, we take advantage of this great vacuum by increasing the speed, which can be done because of the simple rotary motion.

There is, also, the question of heat radiation and cylinder condensation that enter in. The cylinder condensation in a reciprocating engine is proportional to the ratio of expansion, so that the greater expansion we have, the greater will be the amount of initial condensation when steam is admitted, and also the use of the very large engine cylinder increases the radiation losses. A. L. R.

Care of Piston Rings

Is it good engineering practice to round off the sharp corners, or edges, of piston rings, either on new rings or those which have been in use?

2. Does the rounding off of sharp corners justify the result obtained by so doing? F. G. H.

ANSWERS

In regard to rounding off sharp edges of piston rings, we do not know of any engine manufacturer who does this, and would not feel that it would be wise to round them off to any great extent; but it is considered good practice to break the sharp corner sufficiently to get rid of the knife-like edge which tends to scrape the oil off the cylinder walls.

2. In cases where there is no particular difficulty in getting the cylinder to take lubrication properly, rounding off the corners is probably not worth while; but if there is any difficulty in getting the oil to stick to the cylinder walls, it is worth doing, as in a number of instances of which we have known, this has helped considerably in getting satisfactory lubrication. A. L. R.

Required Size of Feed Pump

I have a steam-boiler plant of 500 hp., and I want a feed pump to supply water for it. How am I going to find size of pump I need? M. W. C.

A. In regard to the size of pump necessary for your boiler plant, the usual method of figuring this would be as follows:

A boiler horsepower is supposed to represent 30 lb. of water evaporated per hour. Five hundred horsepower would then represent 15,000 lb. per hr., which at 8⅓ lb. to the gallon would give 1800 gal. per hr., or 30 gal. per min.

We would then have to find a pump which at reasonable speed would yield this volume. A reasonable limitation of pump speed is 50 strokes per minute, and this for a single pump would then give 0.6 gal. per stroke, which would call for about a 5 or 7-in. cylinder.

If a duplex pump were used, making 50 strokes in each cylinder, the cylinder capacity would have to be 0.3 gal. per stroke, which could be 3½ by 7 in., or 4 by 6 in. cylinders. A. L. R.

Requisite Valve Lead

We have an 8 by 10-in. Erie Ball engine with telescopic valve and wish to know how much lead this valve should have when the engine is on center and the governor blocked in its outer position. At present, the lead is 3/16 in. and we have been thinking of turning the flywheel on the shaft and using an offset so that the valve will shut off the steam entirely. Would that be feasible? Kindly advise. O. W. N.

A. The valve should have lap enough so that when the governor is blocked out to the point where the eccentric has the smallest throw, the valve will not open for steam admission at all. It is all right to have it cover the ports as much as 1/16 in.

We do not know what changes have been made, if any, and so can hardly advise, other than to put it in the original shape.

It is possible that the outer stop has been cut off so that when the governor is put in extreme outward position it goes beyond the point of minimum throw. If this occurs, it may account for the excessive lead when the governor is blocked in the outer position.

The suggestion to roll the wheel on the shaft will not help matters in any case. It will make the timing of the valve events incorrect, and it will not change the valve opening at all.

If the governor, as it is at present, cannot shorten the valve travel enough to prevent the ports opening, it is evident that it will not be so merely by rotating the wheel on the shaft. Ball Engine Co.,
E. J. Armstrong.

Using Mixed Fuel

Could you get more steam out of boilers fired with soft coal by adding or mixing crude oil to the coal? If so, would the expense be much more? F. C.

A. Soft coal has a heat value of about 12,000 to 14,000 B.t.u. per lb., depending on the locality from which it comes, and crude oil a heat value of about 20,000 B.t.u. per lb.

If you could get the same efficiency of burning, adding crude oil to the soft coal would give you a greater steam output; but you would have a great deal of difficulty in burning, for the conditions suited for burning soft coal economically are not those for burning crude oil.

One of the difficulties in handling soft coal is to get complete combustion of the volatile gases, and if crude oil were added, it would simply increase the volume of volatile gases, therefore increasing the difficulty of burning. The proposition is not one which can be recommended. A. L. R.

Automatic Governor Operation

If I disconnect the spring of an automatic governor and move the weights by hand, will it move the valve? If so, how much? If not, why? W. G.

A. Moving the weights by hand with the spring disconnected, will move the valve in exactly the same way that it would be moved if the weights were thrown out by centrifugal force, with the engine at speed and with the spring connected.

You must remember that the motion of the weights changes the eccentric action. It is the eccentric that moves the valves, and the governor weights in moving simply set the eccentric in one of 2 ways—either change its travel or change its lead. Moving the weights by hand may, therefore, give but little motion to the valves, depending on the position in which the engine is standing at the time. A. L. R.

Problems For Discussion By Readers

What Would You Do If You Had These Conditions To Meet?

Proper Boiler Operation

WE HAVE several Stirling boilers equipped with B. & W. superheaters, and as there are no provisions made for flooding, the question has come up as to the proper way to get up steam.

Should the boilers be fired up fast or slow, or should they be fired light until a pressure of 25 or 30 lb. is raised and then fired heavy?

We are often called upon to get an extra boiler on the line on short notice, and for that reason would like suggestions from others. A. V. W.

Setting Engine Valves

COULD SOME of Practical Engineer's readers tell me how to set the valves of a 14 by 36-in. Lane and Bodley engine equipped with double eccentrics, but no wrist-plates? The exhaust eccentric is placed next to the main bearing. J. E. N.

Cleaning Gage Glasses

ANSWERING THE inquiry of F. H. J. and J. H. H. in the Dec. 15 issue, blowing through oftener will clean the gage glass if dirty on the inside. It is good practice to blow through them twice a day in stationary and twice every 4 hr. in marine work. If blowing through will not improve them, keep for about 2 hr. as high water level as possible, shut off the gage glass, unscrew top plug, disconnect drain and push through a clean rag using a wooden stick for that purpose. The rag may be slightly soaked with kerosene. If dirty on the outside, rag soaked in warm water will remove the dirt. Care should be taken that the rag should be the same temperature as the glass. I usually hold it for a little while on a steam pipe or the gage glass fittings. If beyond cleaning renew the glass, as there is no excuse for dirty gage glasses. It is a practice with some engineers to pour engine oil through a glass before installing. This will give the glass a thin coat of oil on the inside and prevent impurities from sticking to it.

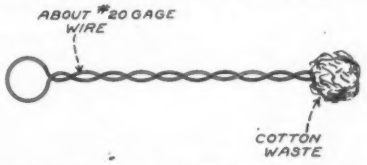
This is to be recommended only in exceptional cases, as an observant engineer can learn a great deal by watching his gage glasses and judge clarity, density, acidity and impurity of his boiler water, apply proper tests, and, which is the main thing, use proper remedies. When certain grades of rubber washers are used, the steam space of the glass becomes a milky color, due to chemical action of the rubber and composition of the fittings. This can be prevented by coating the washers well with graphite. C. B.

IN REPLY to the request of F. H. J. and J. H. H., page 1152, Dec. 15 issue, I submit the following:

When gage glasses become badly stained, they may be cleaned by using hydrochloric (muriatic) acid. Close the lower valve and open the pet cock to empty the gage glass of water. Close pet cock and upper valve. Hold a cup of the acid of ordinary strength under the pet cock and open it to cause the acid to be drawn to the top of the glass. The alternate opening and closing of the upper valve causes the acid to be drawn in and expelled. By doing this 2 or 3 times, a dirty glass may be cleaned thoroughly.

Glasses may also be cleaned by using soap or acetic acid which is applied with a piece of waste forced through the glass by a stick of wood. Do not use a steel wire, as it is injurious to the glass. I. O. SEFFER

IF THE oil is not burnt fast to the glasses a small swab made of some fine wire, twisted long enough to reach the length of the glass and a little wad of cotton waste fastened to the end and then dipped in thick soapy water will help to clean gage glasses.



WIRE SWAB USED TO CLEAN GAGE GLASSES

I have tried this and have found it satisfactory in almost all cases.

Remove the plugs above the gage glasses and swab with cleaner; do not wipe the soapy water off, but leave some of it along the inside of the glass. Then the oil will not adhere to the glass. M. J.

DRAW A cupful of hot water from the boiler into which pour at least a tablespoonful muriatic or other acid; close bottom water gage valve; open top water gage valve and also pet cock at bottom and blow water out of glass, then immediately close the top valve and submerge the end of the pet cock in the cup of hot water solution. A vacuum is created in the gage glass which causes the solution in the cup to rush in.

Keep the pet cock immersed and operate the top valve slightly, opening and closing, alternately expelling and drawing in the solution until all oil, grease or other matter adhering to the inside of the glass is cut out. Then close pet cock and open both water gage valves. It is necessary to have one pound pressure of steam or more on the boiler before commencing this operation. M. CASS.

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Taxing the Gas Engine

Just why the gas engine should be chosen for the subject of a special tax does not appear clear to engineers who are familiar with power machinery.

Presumably the intent is to lay a tax on luxuries, and the use of an automobile is the luxurious habit at which the tax suggestion is aimed. But why the firm which chooses gasoline as motive power, for its trucks should pay, and the electric truck go untaxed is beyond the logic of ordinary mortals. Even why the poor man who gets enjoyment for himself and family by trips in an inexpensive gasoline car should be made to pay extra for it, while the expensive electric coupe is to be left free of the proposed tax, is not quite evident.

But when it comes to stationary power machinery, a special tax on gas or gasoline engines on a basis of horsepower, while overlooking steam engines, turbines, water wheels, electric motors and windmills, seems an absurdity. The farmer or small manufacturer who finds it more economical or convenient to use a gasoline engine is apparently to pay for his necessity or preference a good round sum in tax on his engine and fuel. He who prefers a steam engine or can conveniently secure electric power is to have a considerable advantage in the matter of tax expense.

Special taxation may be necessary to secure the revenue required by our national government, but why handicap the development of a single class of power machinery, which in many situations is the only one economically available?

Just what Congress will do with this suggestion, either as a general proposition or as to details, it is difficult to foresee; but the progress of the discussion should be watched, and those interested in the matter should let their representatives know their views on this important proposed legislation promptly.

Higher Steam Pressures

Better understanding of the science of thermodynamics, advancement in metallurgical processes, discovery of lubricants and packing materials for high temperatures and pressures, as well as improvements in design of boilers and engines combined with a constant and incessant demand for higher efficiencies have been the cause and means by which higher steam pressures are becoming common. There are, however, certain well defined limits in modern practice to the pressure and temperature of steam for power plant use. The subject was ably treated in a paper read recently before the American Society of Mechanical Engineers by Robert Cramer. He places the limiting temperatures employed in steam engine practice at 600 deg. F. for the maximum of the live steam, and 80 deg. F. for the minimum condenser temperature, which corresponds to ½ lb. back pressure.

"In the best present day practice," he states, "except for slightly higher pressures in some few isolated cases, the maximum steam pressure is 200 lb. per sq. in. abs., and the superheat is 200 deg. F. The corresponding temperature of evaporation is 382 deg. F., so that the bulk of the heat is absorbed at a temperature 200 deg. F. below the maximum. It seems reasonable to expect that the approximation to the ideal Carnot cycle, and

simultaneously the economy would be improved by using higher pressure and less superheat."

This opinion, he bases upon a study of the steam tables and the Mollier total heat-entropy diagram which show that the amount of heat convertible into mechanical energy in adiabatic expansion to any given back pressure is considerably higher for high pressure and little superheat than for lower pressure and more superheat, if the maximum temperature of the steam is the same in both cases. It is shown that the ideal efficiency may be increased, where the temperature of the steam is 600 deg. F. and the back pressure ½ lb., from 29.8 per cent to 37.3 per cent by increasing the pressure from 100 lb. to 600 lb.

While this increase is in ideal efficiency, that obtained in practice should show a proportionate gain. There are, of course, mechanical difficulties which must be solved before such high pressure could safely be used in power plants; these involve, principally, changes in design of boilers and engines; but such marked gain in efficiency as a goal, and considering the fact that even higher pressures than 600 lb. have been used with success in internal combustion engines, should be sufficient incentive for determined effort on the part of manufacturers to make higher steam pressures practical and safe.

News Notes

AT THE SIXTH annual meeting of the National Association of Practical Refrigerating Engineers, held at the Chisca Hotel, Memphis, Tenn., an instructive 3-day program was carried out, including reports of President Norman Register and of committees, papers by G. F. Bein on Raw Water Ice, by W. O. Wilson on Diesel Engines for Ice Plants, by Wm. Aldrich on Thermit Welding for Pipes, by G. F. Bell on Refrigeration in Bottling Plants, by J. E. Brandt on Tank Agitation, by W. W. Hughes on Leaks in the Ice Plant, by W. L. Strong on Relation Between Manager and Engineer, and by B. Story on Engineering Department of an Ice and Refrigerating Plant.

Election of officers resulted in the re-election of President Register of Dallas, and Secretary O. E. Morris of Henderson, Tex., and choice of J. W. Marshall, Memphis, as vice-president.

AN IMPORTANT change in the sales organization of the Diamond Power Specialty Co., Detroit, builders of mechanical soot blowers to suit every type of boiler, is the appointment of Robert Porter to succeed Fred Goldthwait as district sales manager of the Boston, Mass., district with offices at 123 Oliver St., Boston. Mr. Porter was formerly in charge of the Providence agency for this company.

WE ARE INFORMED that in view of the great increase in the sales of Steam Traps Sarco and Temperature Regulators Sarco, which have broken all records during 1915, a new company entitled the Sarco Co., Inc., has been formed by the Sarco Engineering Co. and the Roller-Smith Co. of New York City and Bethlehem, Pa. The Sarco Co., Inc., which will handle all sales, will control greatly increased selling and manufacturing facilities. It started operations on Jan. 1 and its address will be South Ferry Building, New York City.

THE TERRY STEAM TURBINE CO., Hartford, Conn., announces the recent appointment of Maynard D. Church as Chief Engineer of the company.

THE COLUMBIAN ROPE CO. has increased its capitalization to $1,500,000. E. D. Metcalf was president of the organization from its foundation by him in 1903 until his death on Dec. 31, 1915. To succeed him Edwin F. Metcalf has been elected president, other officers being T. M. Osborne, vice-president; F. M. Everett, secretary and treasurer; H. G. Metcalf, general manager and assistant treasurer; C. A. Clarke, general superintendent. Its main office is, as heretofore, in Auburn, N. Y., with branches in New York, Chicago, Boston and Providence.

U. S. CIVIL SERVICE COMMISSION announces an examination, Feb. 15, 1916, for master mechanic, to fill a vacancy in the Frankford Arsenal, War Department, Philadelphia, Pa., at a salary of $2400 a year, the appointee to have general but subordinate charge at the Frankford Arsenal of the draftsmen and mechanicians engaged upon the design and construction of telescopes, transits, and similar instruments of precision. Applicants must have reached their twenty-fifth but not their forty-fifth birthday. Apply for Form 2118, stating the title, Master Mechanic (Male), to U. S. Civil Service Commission, Washington, D. C.

U. S. CIVIL SERVICE EXAMINATIONS will soon be held throughout the United States, among which are the following. Between March 13 and June 5, 1916: General mechanic, Departmental Service. On March 15, 1916: Aid, Bureau of Standards (men only); Aid, Coast and Geodetic Survey (men only); Apprentice plate cleaner, transferrer and engraver, Bureau of Engraving and Printing (men only); Assistant examiner, Patent Office; Assistant inspector of boilers, Steamboat-Inspection Service; Assistant inspector of hulls, Steamboat-Inspection Service; Computer, Coast and Geodetic Survey (men only); Draftsman—Topographic copyist in Departmental Service, Engineer Department at large, marine engine and boiler (men only), ship (men only); topographic, in Departmental Service; Engineer, second class (or assistant), steam, Departmental Service; Industrial teacher, Philippine Service (men only); Junior engineer, mechanical or electrical, Engineer Department at Large; Laboratory apprentice, Bureau of Standards (men only); Local inspector boilers, Steamboat-Inspection Service; Local inspector of hulls, Steamboat-Inspection Service. On April 12, 1916: Cadet engineer, Lighthouse Service; civil engineer and draftsman, Departmental Service; Computer, Nautical Almanac Office and Naval Observatory (men only); Computer and estimator, Supervising Architect's office; Draftsman—Architectural, Marine engine and boiler copyist (men only), ship copyist in Navy Department (men only), mechanical in Panama Canal Service (men only), Topographic in Panama Canal Service (men only), Electrician, Departmental Service; Engineer, Indian Service; Engineer, first class, steam, Departmental Service; Junior chemist, Departmental Service; Junior engineer (civil), Engineer Department at Large; Junior engineer (mining), Bureau of Mines; Laboratory assistant, Bureau of Standards (men only); Scientific assistant, Department of Agriculture.

Power Apparatus in Shop and Market

New Ideas In Making, Buying and Selling

Water Heating in an Exhaust Head

SAVING of heat units otherwise wasted is one of the best methods to increase fuel economy, and the appliance herewith described, the Ross Water Heater, Purifier and Oil Extractor, made by the Ross Manufacturing Co., Northville, Mich., is an effective means toward this end.

This Ross heater is of open type, so constructed that it can be placed above the hot water tank, or well, or, if desired, above the roof, the cold water being forced to the heater, and the hot water flowing back to the hot well by gravity.

Exhaust steam enters the heater from the bottom and is distributed through a cone head, with double reversal which takes out all cylinder oil and grease. The steam then passes through a spray of water, much on the same principle as a jet condenser, so that the water and steam are thoroughly mixed. By this means the water is heated, the steam is condensed, and the heated water escapes through the center hot water outlet. Any surplus steam above that required to heat the water passes out at the top through the exhaust steam outlet.

Separate outlet is provided for the oil, which is removed by the reversal of the steam current and drops into the bottom of the outer cone.

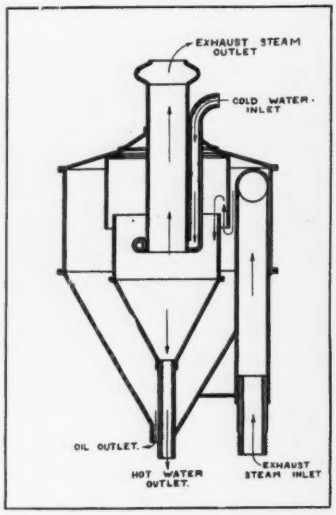


FIG. 1. EXTERNAL VIEW OF THE ROSS WATER HEATER AND OIL EXTRACTOR

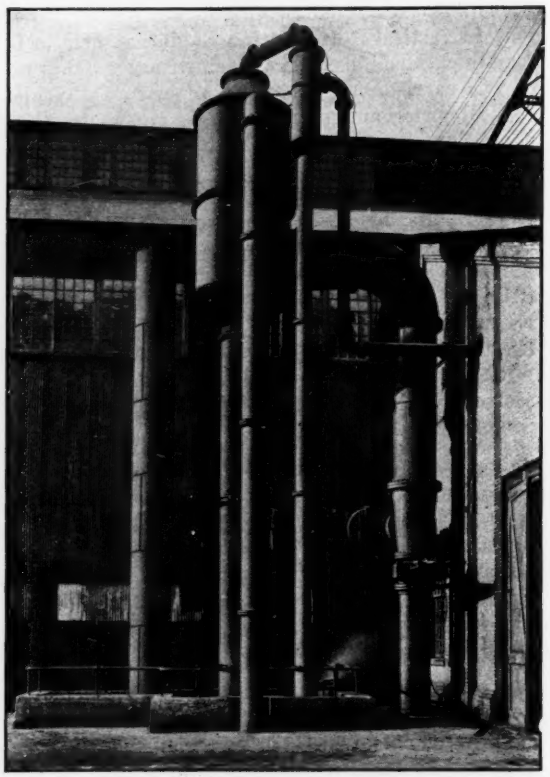
FIG. 2. SECTIONAL VIEW OF THE ROSS HEATER, SHOWING DETAILS OF ARRANGEMENT, CONSTRUCTION AND OPERATION

The arrangement of the parts of the Ross heater, and the flow of steam and water are fully shown by the sectional view, and the exterior appearance, and the method of making connections, by the halftone cut. Installation is simple and can be made in a few hours' time, at slight expense, as connections are all provided to take ordinary pipe runs.

To prove the effectiveness of the device, the manufacturers have a 30-day trial proposition, which eliminates all possibility of unsatisfactory results.

Mesta Barometric Condensers

AS shown in the accompanying illustration, this condenser, made by the Mesta Machine Co., consists of a cast-iron head mounted upon a tail pipe and contains 2 cascades for the liberation of air in the circulating water and below these one long water fall for condensation. At the bottom of the lower fall, openings in the water sheet are provided for the purpose of drawing air and part of the vapor into the inside of the cascade. The thickness of the water sheets is such that no un-



MESTA BAROMETRIC CONDENSER

condensed steam can reach the top of the condenser and yet the resistance of the water to the flow of air in the condenser top is reduced to a minimum.

As the water does not pass through nozzles or atomizers, but falls over weirs positively fastened without bolts or other elements readily attacked by acidified water, pieces of wood, leaves and other trash will pass through without doing any harm.

No free exhaust valve is required. Should the vacuum fail, the water column drops, steam descends through the water leg, and after passing through an opening in the hot well, goes up an auxiliary pipe which discharges the steam at the top.

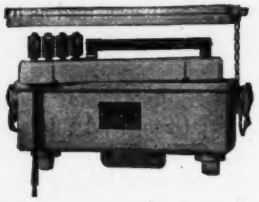
No vacuum breaker is required, as should the supply of circulating water fail, the outer level in the discharge leg automatically drops, opening a wide area for the discharge of the steam. The pressure of the atmosphere cannot force any water into the engine or turbine. Should any heavy and sudden doses of steam occur, coupled with small water-flow, tending temporarily to raise the water in the condenser vessel and carry some of it over into the air pump pipe, a simple tray returns such water to the hot well, allowing air vapor only to reach the air pump.

This condenser is made of cast iron throughout and has no steel or wrought iron parts exposed to the action of the water, so that even a considerable degree of acidity of the water used is harmless.

A Simple 2500-V Lightning Arrester

THE Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., has made an addition to its extensive line of lightning arresters in the form of a low priced spark gap and resistance arrester known as the type CR.

This is a single-pole lightning arrester for alternating-current circuits of any frequency or capacity and for voltages up to 2500. The arrester may be installed



ARRESTER WITH COVER REMOVED, SHOWING 4 NON-ARCING CYLINDERS AND RESISTORS

out of doors on poles or buildings, or indoors on station walls, the weather-proof metal case effectively protecting the arrester units from rain or snow when installed in exposed locations.

When completely assembled, this arrester consists of a series of spark gaps between non-arcing cylinders in series with a resistor. Four cylinders are used for the spark points so that in case of burning, the cylinder can be turned to give a new arcing surface.

The resistor prevents the power arc that might occur on systems of large capacity if the spark gaps alone are used, making the arrester suitable for circuits of any capacity. The resistance is low enough to give good protection, but high enough to insure reliable operation and to enable the non-arcing metal gaps to quench the arc at the end of the first half cycle.

The resistor material is a new composition absolutely unaffected in its resistance by static discharge. The discharge voltage is as low as is practical for use on 1250 or 2500-v. circuits.

The manufacturers recommend one set of type CR lightning arresters at each distributing transformer with a minimum of 5 sets of arresters to the mile of line.

Automatic Stop and Emergency Valves

IN the Ford automatic return check and stop valve, no dashpot is used and the valve is intentionally unbalanced. These features of design are introduced to avoid any tendency to sticking or chattering; also because of the introduction of an apron or piston choke off A, the valve disc must be so far from its seat when any appreciable amount of steam is flowing, that wire-drawing is impossible.

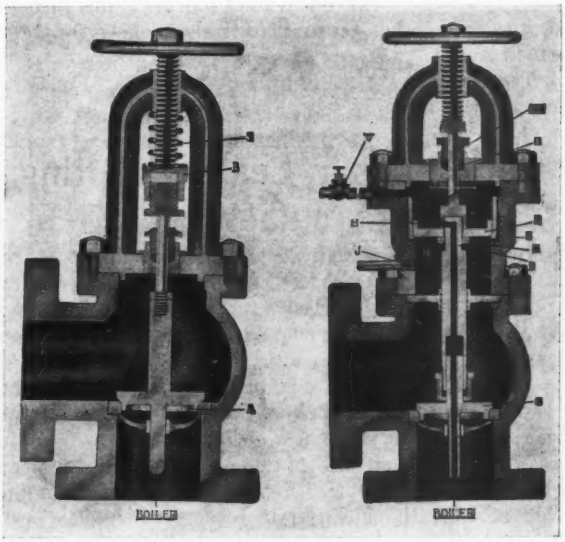


FIG. 1. FORD AUTOMATIC RETURN CHECK AND STOP VALVE
FIG. 2. FORD AUTOMATIC EMERGENCY RETURN CHECK AND STOP VALVE

A novel feature is the adjustable auxiliary spring, S, by which it is possible to secure flow from boiler to main at even pressures, or boiler pressure at any given small excess over the main pressure desirable, by the simple manipulation of adjustment B. This spring is of very light construction, and in no way induces wire-drawing.

As the gland surrounds a sliding rod instead of the stop spindle, it is always possible to see how the valve is operating, an important convenience.

The Ford automatic emergency return check and stop valve operates; 1st, as an automatic check to prevent return of steam from main to boiler in case of a ruptured tube or low pressure in the boiler from other cause; 2nd, as an automatic emergency shut down to

prevent flow of steam from boiler to main in case of a burst pipe or other cause of appreciable drop in pressure in the main; 3rd, as a hand-operated stop valve.

Emergency piston P is made a loose, easy fit, and during normal periods travels upward and is disengaged, allowing the check valve, C, to perform its primary function. On a drop of main pressure in the chamber, M, the boiler pressure acts on top of piston P through hole H, and causes the piston to travel downward, engaging check valve C, to close. Finally the piston, P, reaches its seat, S, and a "dead tight" piston is insured without the use of rings or packing.

In order to have the seats coincide, a screw thread is provided for adjustment of piston P on spindle D to a point of perfect coordination between the seat, S, and the main valve seat, after which the piston is permanently locked in position by the nut, L.

Auxiliary valves are not used, as stock pattern Ford valves are made sensitive to 10 per cent drop in main pressure; this per cent can be varied as conditions may warrant, for the reason that tapping at T B is made amply large and is standardized so that by replacement of gland G and traveling rod AP, by a gland and rod of different size, the per cent sensitiveness is changed.

In this valve also the traveling rod, AP, runs through the packing gland, G, so that it shows how the valve is operating.

These valves are made by The Thomas P. Ford Co., Inc., New York.

Conditions in Leather Belting Manufacture

IN this important field, Chas. A. Schieren gives a brief outline of the retrospect and prospect of the leather belting business as clearly as can be done in a short article, basing the statements largely on the conditions found by his own company.

Last July, a sudden advance in the price of leather occurred, and since that time, Chas. A. Schieren Co. has been deluged with business, which it has met by increasing the capacity of its tanneries 50 per cent, meanwhile buying great quantities of belt leather, but finding, even at this, the business increasing every day, with orders now on hand for 4 or 5 months ahead, some orders which were received as far back as last August not yet being entirely completed.

English and German competition has been largely eliminated in the foreign field, this applying to the British Colonies, South America, South Africa, the East Indies and the Dutch East Indies. Representatives in these various fields have consequently increased their business from 100 to 500 per cent during the past year, which indicates pretty clearly the situation in the foreign field.

In domestic trade, the enormous quantity of war munitions being manufactured has created unprecedented demand for leather belting, many new plants having been developed so quickly, that they have ordered great quantities of belting for shipment within a short time, a demand which it has been almost impossible to supply. This business will, of course, fall off when the war in Europe ceases, but general demand is increasing over all sections of the country. This movement started about the middle of September, and all over the country people are now buying more leather belting than for several years past, so that Mr. Schieren looks for a remarkable period of prosperity in the United States over a term of years.

So far as business after the war is concerned, one can only judge by past history. During the Franco-Prussian war, which lasted some 10 months, England's export business increased slightly, but not to a marked degree. In the 4 years following this war, however, England's export business with France and Germany increased over $400,000,000. The present war breaks all records, and it would be conservative to multiply these figures by 10 when estimating the increased export business that the United States will enjoy during the months, or perhaps years, after hostilities cease. The countries which have been at war will want all kinds of equipment, and will call on us for everything, which Mr. Schieren believes will cause a remarkable era of prosperity at that time.

Books and Catalog

LABORATORY TESTS OF A CONSOLIDATION LOCOMOTIVE, by E. C. Schmidt, J. M. Snodgrass and R. B. Keller has been issued as Bulletin No. 82 of the Engineering Experiment Station of the University of Illinois. The tests whose results are recorded constitute the first work done in the recently established locomotive laboratory of the University of Illinois and relate to a typical consolidation locomotive.

The maximum amount of dry coal fired per hour was 11,127 lb., or 224.5 lb. per sq. ft. of grate per hour. The maximum equivalent evaporation per hour was 57,954 lb., or 17.65 lb. per sq. ft. of heating surface per hour. The cinder losses ranged from 3 to 16 per cent of the weight of dry coal fired for what might be considered ordinary service conditions and amounted to 27.4 per cent of the weight of the dry coal fired during one test under extreme conditions of firing and draft.

THE CLING-SURFACE CO., of Buffalo, N. Y., has issued a special calendar, dedicated to the National Association of Stationary Engineers, and as long as the supply lasts will gladly send a copy to any member who applies to them for one.

HELPFUL HINTS on Air Compressor Installations is the title of a booklet recently published by the Gardner Governor Co., Quincy, Ill. Important points in regard to selection, location, lubrication, speed, cooling, repairing, etc., of compressors are discussed in concise language in order to be of greatest help to the man on the job.

THE FIFTH EDITION of "Making Heat Produce" has been issued by the Diamond Power Specialty Co., Detroit, Mich., builders of Mechanical soot blowers to suit every type boiler. The newest edition is pocket size and its 14 pages contain information that is of much interest and value to everyone having to do with the care and operation of boilers. This book is not an advertisement for Diamond Soot Blowers but was written by Dr. S. J. Herman, an authority on combustion problems, whose statements are based on facts.

A copy of this book will be sent to anyone on request.

FROM THE Wheeler Condenser & Engineering Co., of Carteret, N. J., are received 2 useful tables, one Steam Table for Condenser Work, covering in great detail pressures below atmosphere, and giving a discussion of the use of the mercury column and constants for correction. The other is Psychrometric Tables for Cooling Tower Work, showing the wet and dry bulb thermometer readings, dew point, humidity and pounds of water contained in each thousand cubic feet of air at various temperatures. The table is invaluable for cooling tower computations. These tables are available for those who have use for them, on application to the above mentioned company.

FINDING AND STOPPING of Waste in Modern Boiler Rooms is the title of a 68-page book devoted to the use and design of Cochrane meters, issued by the Harrison Safety Boiler Works, Philadelphia, Pa. The value of feed water and condensate meter as aids in the management of power plants is taken up in detail in the introductory part of the book, covering, among other factors, grade of fuel, grates, methods of firing, air leaks, control of draft, condition of gas passages, scale and soot on boiler tubes, radiation, etc. In the subsequent sections of the book, the Cochrane metering heater (combined open feed water heater and hot water heater), with its several modifications, is described in detail, as also the Cochrane flow record for use in connection with V-notch weirs. In the last pages of the book a new type of meter, working on the volumetic principle, by means of which it is possible to obtain great accuracy, as within ⅓ of 1 per cent, is described.

BUREAU OF MINES offers the following among new publications: Bulletin 97, Sampling and analyzing flue gases, by Henry Kreisinger and F. K. Ovitz; 1915; 676 pp., 1 pl., 34 figs.; points out the value of analyzing flue gases and describes a simple apparatus and the method of using it; of interest to all persons in charge of boiler plants. Technical Papers 114, Heat transmission through boiler tubes, by Henry Kreisinger and J. F. Barkley; 1915; 36 pp., 23 figs.; a plain and simple description of the manner in which the heat of a furnace fire reaches the water in the boiler; of interest to all persons who design boilers or have charge of boiler plants.

Only a limited supply of these publications is available for free distribution, and applicants are asked to co-operate in insuring an equitable distribution by selecting publications that are of especial interest. Requests for all papers can not be granted. Publications should be ordered by number and title. Applications should be addressed to the Director of the Bureau of Mines, Washington, D. C.

WESTINGHOUSE Railway Motors Nos. 306-V, 307-V, 333-V and 547-A are thoroughly described and illustrated in a series of leaflets just issued by the Westinghouse Electric & Mfg. Co., Nos. 3837, 3765, 3833 and 3835 respectively.

The particular characteristics of these motors, together with detail views of construction, and operating curves are given.

Alternating Current Magnet Switches, Type F, for industrial service are described in leaflet No. 3551-A, just issued. These switches have been designed with a view to fulfill the severest requirements of industrial service, and their details of construction and operating characteristics are given in the leaflet, together with illustrations of them mounted on panels.

Alternating Current Low-Voltage Switches, Type EA, are described and illustrated in leaflet 3849. Diagrams of typical connections are given and the construction of the board thoroughly described.

THE DIAMOND POWER SPECIALTY CO., Detroit, builders of mechanical soot blowers to suit every type of boiler, recently issued a handsome catalog in loose leaf form. The cover is very striking, being printed in 3 colors, the arrangement presenting a poster effect. This catalog contains bulletins describing the various types of mechanical soot blowers and also several bulletins descriptive of the construction of the various models. One of these gives in detail the facts about the Diamond Insuluminum unit. This is the aluminum insulated unit used in the Diamond system for horizontal water tube boilers.

The company has also issued a cleverly written booklet entitled "If Your Smokestack Could Talk."

THE GENERAL ELECTRIC CO. has just issued Bulletin No. 48,017, which refers to the application of electricity in the harvesting of natural ice. The bulletin is illustrated with views of various installations of motors for driving basin saws, field cutter, channel pusher, house ice cutter, and shows the use of a motor-driven hoist in ice storage. There are also illustrations of various motors applicable to this work.

METERS FOR AUTOMOBILE TESTING are described and the particular advantages brought out in folder No. 4321 just issued by the Westinghouse Electric & Mfg. Co.

BOILER GRAPHITE FACTS discussed in a booklet from Dixon Crucible Co., Jersey City, N. J., compare flake graphite with amorphous and tell how to feed Dixon's boiler graphite.

CORKBOARD CATALOG entitled Nonpareil Corkboard Insulation, just issued by Armstrong Cork Co., Pittsburgh, Pa., contains much information of value to those interested in heat insulating materials for low and moderate temperatures.

Trade Notes

THE COMBINED open feed water heater and hot water meter known as the Cochrane Metering Heater, exhibited at the Panama-Pacific Exposition by the Harrison Safety Boiler Works, 17th St. & Allegheny Ave., Philadelphia, has received the Gold Medal award. This apparatus is designed to heat boiler feed water by means of exhaust steam from engines, pumps, etc., and simultaneously to meter the water and record the rate of flow, and to integrate the total flow in any elapsed period. This enables the engineer or plant owner to determine how many pounds of steam are being evaporated per pound of fuel burned under the boilers, and hence to compare the different fuels, different methods of firing, etc. It also shows the effect upon boiler efficiency of cleaning soot and scale off heating surfaces, stopping up

air leaks in furnace and settings, and other improvements in operation, and furnishes the means whereby the methods of obtaining high efficiency may be discovered, standardized and maintained.

SPRAY ENGINEERING Co., Boston, Mass., reports that the 2 Spray Engineering Co. air washers and coolers installed as auxiliaries to the 35,000-kw. and the 30,000-kw. steam turbo-generator sets in the new A-2 Christian St. station of the Philadelphia Electric Co., are for the largest pair of units in the world. Other recent installations of the Spray air washers and coolers are the following:

	Capacity Cu. Ft. Per Minute.
Lawrence Gas Co., Lawrence, Mass	25,000
Lynn Gas & Electric Co., Lynn, Mass	16,000
Cambridge Electric Light Co., Cambridge, Mass	25,000
United Electric Light & Power Co., New York, (3) each	50,000
National Conduit & Cable Co., Hastings, N. Y	25,000
Commonwealth Edison Co., Chicago, Ill. (3) each	80,000
Consolidated Gas, Electric Light & Power Co., Baltimore, Md.	12,520
Merchants Heat & Light Co., Indianapolis, Ind	72,000
Toledo Railways & Light Co., Toledo, Ohio	70,000
Public Service Electric Co., Essex, N. J. (2) each	60,000
North American Chemical Co., Bay City, Mich	30,000
Evansville Public Service Co., Evansville, Ind	25,000
Eastern Penn. Railways Co., Palo Alto, Pa	20,000
Minneapolis General Elec. Co., Minneapolis, Minn.	50,000
New Orleans Railway & Light Co., New Orleans, La.	50,000
Mobile Electric Co., Mobile, Ala	16,000
Lowell Electric Light Corp., Lowell, Mass	25,000

THE BAILEY METER CO., 141 Milk St., Boston, Mass., has been incorporated under the laws of Massachusetts to manufacture and sell a most complete line of recording meters and instruments for power plant and other similar uses. These meters have been developed during the past 6 yr. in the mechanical engineering department of the Fuel Testing Company of Boston.

E. G. Bailey will devote his entire time to the new company, but the Fuel Testing Company will continue its regular line of work under the personal direction of W. B. Calkins, who has been a partner with Mr. Bailey since its organization in 1909.

Bailey meters are adapted to measure accurately steam, water, air and gases, under all conditions of pressure, temperature and capacity. They include orifice meters for all fluids in pipes; V-notch weir meters for open flow liquids; "The CO_2 Method of Steam and Water Measurement" for meter calibration and testing work; boiler meters showing steam output, rate of air supply and condition of fuel bed; gas flow meters for fan and ventilating ducts; and radiimeters for averaging all kinds of chart records. This entire line of meters and instruments is fundamentally new, embodying simplicity of design and durability of construction and work satisfactorily and continuously under severe power plant conditions.

The Bailey Meter Co. is prepared to take up all problems relating to the flow of fluids. Descriptive literature sent upon request.

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Trade-mark, Reg. U. S. Pat. Off.

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Position Wanted

POSITION WANTED—As Electrician and Engineer. Am experienced in installing, maintaining and repairing in steam heating, A.C. and D.C. plants. Desire to take charge where improvements will be welcomed. Address J. F. K., 877, 10th Ave., Milwaukee, Wis. 2-1-1

POSITION WANTED—As Boiler Room Superintendent by licensed engineer, familiar with boilers, water softening and CO_2 analysis. Strictly sober and reliable. Address Practical Engineer, Box 420, Chicago, Ill. 2-1-1

POSITION WANTED—As chief engineer. Have had extensive experience in operating, overhauling and erecting ice making, packing house and cold storage plants. Efficient and economical. Best results assured. Can furnish A1 references. F. J. Baumann, 511 East 84th St., New York, N. Y. 2-1-1

POSITION WANTED—By man with 18 yr. practical experience—4 yr. in general repair shop and 14 yr. in running engines. Have had considerable experience with Electric Light Plants, Flour Mills, as night Superintendent of Water Works, and Engineer in Oil Mill. I prefer night work (compressors) in Oil Mill if steady work. 36 yr. old. Married. Sober and steady worker. References. At present employed but desires change. Address Practical Engineer, Box 416, Chicago, Ill. 1-15-2

POSITION WANTED—By man who has made steam engineering a life study; have had several years' experience; at present am student in Complete Steam Engineering course with I. C. S. Would like position as engineer, assistant or oiler, with reasonable salary to start, and where I can advance according to merits. Age 26. Address Practical Engineer, Box 419, Chicago, Ill. 1-15-2

POSITION WANTED—Young man wants position as helper and extra engineer in steam plant for a start. Other particulars answered by letter. Write W. D. Bellesfield, Rock Valley, Iowa. 2-1-1

POSITION WANTED—As Chief Engineer. Am qualified to take full charge of power plant, A.C. or D.C., also refrigeration. Age 30. Married. Employed. Chicago only. Address Practical Engineer, Box 421, Chicago, Ill. 2-1-1

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WANTED—A Salesman with Technical Education as Mechanical Engineer. We have an opening for a man who has received a technical education as Mechanical Engineer, and who is experienced as a salesman, to become Head Salesman of our Heavy Capacity Automatic Scales for factory and warehouse uses. He should not be younger than thirty nor older than forty years. His personality should be such as to fit him to associate successfully with traveling salesmen and prospective purchasers of Heavy Capacity Scales. This will be a traveling position. The man should make his residence in Toledo, but will spend only one-third of his time here in our factory office and two-thirds in the field. He must be qualified to talk with authority on the subject of Mechanics with Factory Superintendents, Engineers and Scientific Men, as well as to co-operate effectively with our own corps of Engineers in the development of the Heavy Capacity Scales. He must have executive ability and be qualified not only to sell the scales himself, but to employ, instruct and direct other salesmen. This is a difficult position to fill. It requires a man with an unusual training. We are willing to pay a liberal salary. Address Henry Theobald, President, Toledo Scale Company, Toledo, Ohio. All communications will be guarded as strictly confidential.

WANTED, STATIONARY ENGINEER—The Illinois State Civil Service Commission will hold an examination for this position at Chicago, Kankakee and Lincoln on February 5, 1916. Salary $75 to $100 a month. Open to men over 25 years, residing in Cook, Kankakee, Iroquois, Logan and De-Witt counties. For details and applications, address State Civil Service Commission at Springfield, Ill., or 904, 130 North Fifth Ave., Chicago.

WANTED—Resident subscription agents in the following cities; Atlanta, Ga.; Cincinnati and Columbus, Ohio; Kansas City, Mo.; Los Angeles, Cal.; Louisville, Ky.; Newark, N. J.; New Orleans, La.; Portland, Ore.; St. Louis, Mo.; San Francisco, Cal.; Washington, D. C. This is an excellent chance for a hustler, who is familiar with power plant conditions, to turn his spare time into dollars. To such a one we offer a Real Opportunity. Write Subscription Department, Practical Engineer, 537 S. Dearborn St., Chicago. tf.

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Wanted

WANTED—A refrigeration engineer for plant in Western Pennsylvania. Must be familiar with refrigeration, ice making, gas engines and electrical machinery. Capacity of plant, 25 tons of ice per day. State salary wanted. Address Practical Engineer, Box 418, Chicago, Ill. 2-1-1

WANTED—Agents handling engine and boiler-room specialties in every section for side line paying large commissions. Give experience, line carried and territory covered. Address Practical Engineer, Box 381, Chicago, Ill. tf.

WANTED—Agents on commission to sell our Shaking Grates. We will install grates on trial or put it on test at our expense with any grate made. Address Armstrong Mfg. Company, Springfield, Ohio. tf.

WANTED—An oil filter to manufacture and sell on a royalty basis or will buy outright. Give full particulars, with sketches, in first letter. Address Practical Engineer, Box 422, Chicago, Ill. 2-1-1

WANTED—One Corliss, steam-driven refrigeration machine, 15 to 30-ton capacity, with oil traps and condensers. One belt-driven refrigeration machine, 15 to 30-ton capacity, style horizontal or vertical, in first-class condition. Address Universal Ice & Cold Storage Company, Monongahela City, Pa. 2-1-1

For Sale

BOILERS: (two) 250-hp. Heine water-tube boilers, 150 lb., $950 each; (four) 300 hp. Sterling water-tube boilers, 150 lb., $1100 each; (one) 500-hp. Sterling water-tube boiler, 200 lb., $1750. 110-volt lighting dynamos, General Electric make, 30-kw., $200; 25-kw., $175; 20kw., $160; 14-kw., $140; 9-kw., $100. Duzets & Son, 50 Church St., New York, N. Y. tf.

FOR SALE—15-H.P. combined tandem gasoline engine and air compressor. Used only two weeks. Can be operated as gasoline engine or air compressor alternately; 67 cu. ft. free air displacement. Weber Subterranean Pump Co., 90 West St., New York. 2-1-2

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PATENTS THAT PROTECT AND PAY—Advice and books free. Highest references. Best results. Promptness assured. Send sketch or model for search. WATSON E. COLEMAN, Patent Lawyer, 624 F St., N. W., Washington, D. C. tf.

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PATENTS—H. W. T. Jenner, Patent Attorney and Mechanical Expert, 606 F St., Washington, D. C. Established 1883. I make a free examination and report if a patent can be had, and the exact costs. Send for full information. tf.

A. P. CONNOR, Consulting Electrical and Mechanical Engineer. Attorney-at-Law and Solicitor of Patents and Trade-Marks. Results guaranteed. 121 Carroll St., S. E., Washington, D. C. tf.-x

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Miscellaneous

ENGINEERS, DO YOU WANT to utilize your exhaust steam for heating or drying purposes, without back pressure on your engine? If so, address Monash Engineering Co., 1413 W. Jackson Blvd., Chicago, Ill.

Inventions

INVENTIONS commercialized on cash and royalty basis. Inventors and manufacturers should write Adam Fisher Mfg. Co., 2175 Railway Exchange, St. Louis, Mo. tf.

Sparks From The Advertising Pages

It would be impossible to place a valuation upon such an important institution of information as the public press.

Can you imagine Chicago or New York or any town of reasonable size without its daily paper, or can you imagine a great body of professional men or tradesmen, physicians, musicians, teachers, lawyers, architects, engineers, printers, carpenters, masons, etc., without a paper pertaining to their vocation? It is safe to assume that their vocational paper is worth more to these men than their apprenticeship or preliminary school work—it is the medium through which all news and timely information on their chosen field is disseminated, and because of changing methods and devices it is absolutely indispensable.

The smallest hamlet realizes the importance of the press and it is unfortunate that there is a town within our borders which has to display a sign beside the railroad tracks, bearing these words, "Please throw us your papers". The town grew up in a mining district and the mines have given out. It is too poor to support a paper of its own or to get a sufficient quantity from more prosperous towns, adjacent so papers a re thrown from the passing trains. The news is old, but nevertheless appreciated.

We of the city and town do not fully realize and appreciate the many conveniences at hand. Our paper is delivered right to the door and the news is up to the minute. Our magazines, trade and technical journals are delivered in post haste, and because of this convenience their real value is usually underestimated. Hence we quite frequently read without discrimination and skip or scan or read such sensational news as the divorce suits, mysterious murders, scandals, etc., to the exclusion of all else.

While a little of this is necessary to keep posted on timely events, it is more profitable to assimilate the news that is a stimulant to mental growth, such as civics—political economy—politics—philosophy — literature—science and the host of other subjects that every newspaper endeavors to cover.

We raise this point to emphasize the importance of discriminate reading and to furnish an example for comparison.

Your daily paper is of course important to you but it can never equal the importance of your vocational paper—for this is a direct help in your daily work—in developing yourself—assisting you in lightening your duties—in shortening your methods—in keeping your equipment at a high standard of efficiency, and as the housewife makes up her buying list from the announcements in the daily papers, you should make up your buying list of the things needed in your plant from your power plant paper. That's one of the reasons it exists—to bring together the producer and consumer in a legitimate business transaction, to assure the buyer a safe and saving purchase—and the manufacturer a chance to create a patronage built entirely upon "good will".

There is absolutely no excuse for buying unadvertised products, in fact, there is an element of danger. This is readily proven by the fact that all successful manufacturers continue to advertise to maintain the "good will" of their patrons and to show them that their product is still up to standard quality.

Maintaining "good will" necessitates the maintenance of quality.

So take this issue of Practical Engineer and do not skip nor scan its advertising pages, but read them as Bacon says, "to weigh and to consider".